VOL. 11, No. 12 DECEMBER, 1934

Medical Library
610.5
A5
J86
065
V.11
no.12

The AMERICAN JOURNAL of OPTOMETRY

EDITORS

CAREL C. KOCH JACK I. KURTZ

COLLABORATORS

E. B. Alexander, *Duncan, Okla.*
J. Fred Andreae, *Baltimore, Md.*
J. O. Baxter, Sr., *New Bern, N. C.*
L. L. Beacher, *New York, N. Y.*
O. E. Bell, *Fairmount, W. Va.*
Robt. T. Best, *Fairmont, Minn.*
W. I. Brown, *New Bedford, Mass.*
J. T. Campbell, *Washington, N. C.*
R. G. Colberg, *Aberdeen, S. D.*
Paul Dill, *Greeley, Colo.*
H. C. Doane, *Boston, Mass.*
J. H. Drakeford, *New York, N. Y.*
G. L. DuPlessis, *Minneapolis, Minn.*
T. H. Eames, *W. Somerville, Mass.*
W. S. Farmer, *Oklahoma City, Okla.*
Wm. Feinbloom, *New York, N. Y.*
L. P. Folsom, *South Royalton, Vt.*
H. L. Fording, *Portland, Ore.*
F. W. Freeman, *Anderson, Ind.*
M. Gilbert, *Owosso, Mich.*
W. H. Glazer, *Philadelphia, Pa.*
R. M. Hall, *Cleveland, Ohio*
C. H. Hathaway, *Pontiac, Mich.*
C. K. Haynes, *Jamestown, N. Y.*
A. E. Hoare, *Los Angeles, Calif.*
B. T. Hoffman, *Chicago, Ill.*
H. S. Horton, *Cleveland, Ohio*
E. E. Hotaling, *New York, N. Y.*
C. E. Jaeckle, *Newark, N. J.*
Chester Johnson, *Philadelphia, Pa.*
H. D. Judd, *Detroit, Mich.*
B. E. Kehl, *St. Louis, Mo.*
L. H. Kraskin, *Washington, D. C.*
N. Levin, *Chelsea, Mass.*
R. E. Littlefield, *Kansas City, Mo.*
J. J. Livingston, *Little Rock, Ark.*
C. V. Lyons, *San Francisco, Calif.*
G. A. MacElree, Jr., *Phila., Pa.*
F. L. Mason, *Berkley, Calif.*
D. J. Mayer, *Riverside, Calif.*
O. L. McCulloch, *Holyoke, Mass.*
Wm. Mendelsohn, *Chicago, Ill.*
F. McFadden, *Rutland, Vt.*
O. J. Melvin, *Omaha, Nebr.*
M. B. Meyer, *Wilmington, Del.*
J. K. Morris, *Erie, Pa.*
J. C. Neill, *Philadelphia, Pa.*
J. Neumueller, *Philadelphia, Pa.*
M. M. Ocshier, *W. Springfield, Pa.*
G. Oertel, *Syracuse, N. Y.*
G. O. Ohlsson, *Detroit, Mich.*
C. R. Padelford, *Fall River, Mass.*
D. R. Paine, *Topeka, Kan.*
Geo. A. Parkins, *Ord, Nebr.*
J. I. Pascal, *New York, N. Y.*
R. J. Pearce, *Greensboro, N. C.*
R. M. Peckham, *Rochester, N. Y.*
Ernest Petry, *Rochester, N. Y.*
S. H. Robinson, *Prescott, Ariz.*
A. N. Prussin, *Detroit, Mich.*
E. LeRoy Ryer, *New York, N. Y.*
H. L. Salov, *Newark, N. J.*
Charles Sheard, *Rochester, Minn.*
Carl Shephard, *Chicago, Ill.*
R. E. Simpson, *Pasadena, Calif.*
W. Smith, *Dorchester, Mass.*
H. R. Spitler, *Eaton, Ohio*
M. J. Stark, *Union City, N. J.*
M. Steinfeld, *Paducah, Ky.*
Edwin Forbes Tait, *Phila., Pa.*
H. Thomas, *Wenatchee, Wash.*
S. S. Titus, *Kansas City, Mo.*
R. N. Walker, *Winston-Salem, N. C.*
A. P. Wheelock, *Des Moines, Iowa*
A. C. Whitaker, Jr., *Bridgeton, N. J.*
E. G. Wiseman, *Buffalo, N. Y.*
A. T. Wray, *Los Angeles, Calif.*
L. K. Wyatt, *Peoria, Ill.*

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION,
1501 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.

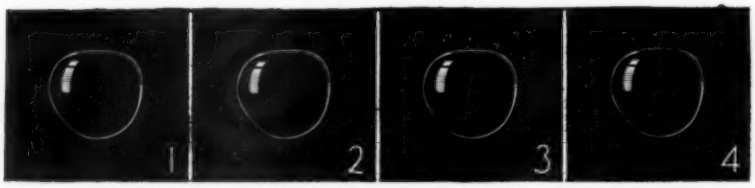
ANNUAL SUBSCRIPTION $4.00. CANADA AND FOREIGN $5.00

Entered as second-class matter February 20, 1924, at the postoffice at Minneapolis, Minnesota, under the Act of March 3, 1879.

UNIVERSITY OF MICHIGAN
MEDICAL LIBRARY

REDOUBLED EFFORTS

Today science is redoubling its efforts to protect our eyes from glare. Illuminating experts are planning and experimenting with "glare-free" sources of artificial light. We are beginning to realize the fact that too *much light means no sight* . . . Glare, however, isn't produced only indoors. In all our waking hours, both indoors and out, our eyes are punished by countless sources of reflected light, annoying and fatiguing, eventually resulting in a condition of strain—glarestrain. For protection and complete comfort prescribe Soft-Lites, the lenses that reduce glare and provide easy, effortless vision.



1	2	3	4
For constant wear. It provides comfortable vision without glare-strain. For eyes sensitive to mild forms of glare. Pleasing appearance.	*For constant wear. It provides a slight increase of light absorption over No. 1 shade. For eyes supersensitive to glare. Inconspicuous.*	*This shade is for occasional wear. It provides protection from outdoor glare as found in motoring, golfing, tennis and other outdoor sports.*	*For occasional wear. It provides protection from intense outdoor glare as at the beach, fishing, boating, or in semi-tropical areas.*

AN ADVERTISEMENT OF THE SOFT-LITE LENS CO., Inc.

AMERICAN JOURNAL OF OPTOMETRY

Vol. 11 DECEMBER, 1934 No. 12

CONTENTS

ORIGINAL PAPERS

Considerations Regarding the Analysis and Interpretations of Data on Ocular Convergence. Charles Sheard 448

An Experimental Investigation of the Negative Fusional Convergence Aplitude. William J. Tait 462

EDITORIALS

Refractive Errors in Children 473

The Muscles of the Iris and Their Action 474

Benjamin Franklin, the Inventor of Bifocals 475

BOOK NOTICES

Diseases of the Eye. Sir John Herbert Parsons 476

Cataract, Its Etiology and Treatment. Clyde A. Clapp 477

Strabismus. Henry Rich Higley 477

ANNUAL INDEX . . . . . 479 to 489

WRITE FOR —

Our New Style Book

•

N. P. BENSON OPTICAL CO., Inc.

ESTABLISHED 1913

MINNEAPOLIS, MINN.

Duluth Aberdeen LaCrosse Bismarck Eau Claire Rapid City Wausau

WHICH ?

GUESSWORK or

PRECISION

When the Lensometer was first introduced some twenty years ago, we called it an Optical Sentinel. It was a magical instrument - a mechanical eye. It replaced the primitive, uncertain methods of analyzing lenses that had prevailed up to that time. It changed lens testing from a guessing game to a science.

But improvements in the Lensometer during the past twenty years have been numerous. Instead of an optical sentinel it has become the "Supreme Court of Lens Accuracy"- without doubt, the most precise ophthalmic lens measuring device that has ever been conceived.

And now we announce still another step in the improvement of our Lensometer Jr. - a brand new model, newly designed, with several new mechanical features - at no increase in price.

To those who still employ antiquated methods of lens testing we say; See the new Lensometer Jr. in action; see the preciseness with which it records the effective power of spheres, cylinders and compound lenses; indicates exact axes and centers; and determines the power and direction of prisms. See these things and you will know how necessary to your practice is the new AO Lensometer Jr.

NEW AO LENSOMETER Jr.

AMERICAN OPTICAL

AMERICAN JOURNAL OF OPTOMETRY

Vol. 11 DECEMBER, 1934 No. 12

CONSIDERATIONS REGARDING THE ANALYSIS AND INTERPRETATION OF DATA ON OCULAR CONVERGENCE*

Charles Sheard, Ph.D., Sc.D.
Division of Physics and Biophysical Research, The Mayo Clinic and The Mayo Foundation, Rochester, Minn.

PART III

The Function of Accommodation

In 1917 Howe closed one of the chapters of his first volume on The Muscles of the Eye with the statement: "Of late years American ophthalmologists particularly have taken great pains to determine the condition of the extra-ocular muscles and have been so engrossed with these alone that physiologic facts concerning the intra-ocular muscles which were demonstrated long ago, and which are still of the first importance clinically, have been forgotten." While I am of the opinion that twenty or so years ago relatively few of the rank and file of ophthalmologists or optometrists gave any consideration to examinations regarding the extra-ocular muscles, and if so, then almost wholly from the anatomic (squints and operative procedures) rather than from the innervational standpoint, I am also of the opinion that the admonition of Dr. Howe, with some minor changes in diction, bears repetition in these days. By reason of the emphasis which is being laid on the problems of convergence—a function which some believe to be the dominant one in the association of accommodation and convergence—it is possible that too little regard and concern are given to problems of accommodation other than those which are brought quite obviously to the attention of the examiner because they are frank conditions of presbyopia. We have inefficiency and insufficiency of accommodation, physiologic accommodation, monocular and binocular demands and reserves, positive and negative relative amplitudes, dependence and interdependence of accommodation and convergence, so that, in large part, we may parallel our considerations relative to the function of accommodation with the presentation which has been made in another essay concerning the function of convergence. As a matter of fact, a recent writer, after presenting and discussing the innervational sources of ac-

*Submitted for publication October 22, 1934.

commodation and convergence, concludes "that we may place side by side the five sources of accommodation and convergence" (tonic, convergent, proximate, induced, and supplementary), "and the reader will see at once their common sources of interdependence."

Objective Monocular and Binocular Data with Fixation at Distance

Static skiametry is an objective method for the determination of the refractive status of an eye when the eye is in a condition of passively fixating a distant object. Accommodative suppression and inhibition are to be induced as completely as possible. Ordinarily it is taught, and correctly from theoretical principles, that an allowance of 1 diopter should be made in static findings for a working distance of 1 meter. However, in monocular static skiametric procedures, I have advocated as a routine procedure that the examiner use 26 to 30 inches as a working distance and make an allowance of 1 diopter instead of the theoretical allowance of 1.5 diopters. The skiascopic findings thus obtained approximate the values of the binocular prescription finally determined in the majority of eyes in which normal relationships exist between the accommodative and convergence functions.

Another procedure, which may be followed routinely, consists in the insertion of sufficient prismatic power before the eyes (or the eye which is not being examined) to dissociate the functions of accommodation and convergence. Others employ such amounts of lenticular power before the eyes as overcorrect them very decidedly, and then proceed to the determination of the neutral shadow values monocularly.

Binocular static findings should be obtained after the monocular tests have been made. There are several advantages accruing to the examiner. First, the possibility of binocular relaxation or accommodative inhibition is greater than in monocular procedures, whether these be skiascopic or subjective in character. In the second place, it follows as a logical conclusion from the foregoing statement that if the binocular findings are the same or less than the monocular data in hyperopia or, again, are the same or greater in myopia, the examiner is afforded a clue as to the probable presence of complicating extra-ocular imbalances. Thirdly, it is a safe rule to follow in routine practice that the maximal hyperopic and minimal myopic corrections should be disclosed and recorded even though, by reason of subsequent tests on the demands on, and resources of, convergence and accommodation, it may be judged desirable to modify the binocular findings. And lastly, it is good practice to ascertain by objective methods, both with distant and close fixation, whether or not the axes and amounts of astigmatism are the same in binocular as in monocular fixation.

Amounts of plus (convex) lens power ranging from 0.5 diopter to as high as 2 diopters may be added binocularly to the previously determined monocular findings before neutral shadows are obtained.

Subjective Monocular and Binocular Data with Fixation at Distance

It is not necessary to rehearse the procedures regarding subjective methods for the determination of monocular and binocular lenticular corrections with fixation at distance. Suffice it to say that these data should be obtained with care and precision by subjective methods, for it is obviously the function of the examiner to provide the pair of eyes under test with lenses which will as fully correct the refractive errors and afford the best visual acuity possible, departures therefrom being indulged in only in the interests of comfortable binocular single vision through the harmonious correlation of accommodation and convergence.

Dynamic Skiametry as a Guide to the Determination of the Accommodative Requirement

It is not my purpose to enter into a lengthy discussion of the various methods of obtaining data by dynamic skiametry and their interpretation. Reference should be made to the writings of Cross, Sheard, and Tait, as well as to the recent volume on modern retinoscopy by Pascal.

I have advocated the use of dynamic skiametry, as a general rule, with observation and fixation at the reading or other desired close working distance, for the determination of the lenticular values necessary to produce the *first* indication of neutral shadow. There is a range of neutral shadow skiametrically existent between the point of initial neutrality of shadow and the reversal of shadow. The significance of this range will be discussed later.

Furthermore, in 1919 I published the statement: "I feel rather positive from a long series of tests by various methods of skiametric investigation that there is always a *lag of the accommodation* behind the convergence." In eyes practically emmetropic in so far as any static or subjective tests indicated, possessed of adequate amplitudes and reverses of accommodation and convergence, and therefore as nearly physiologically normal as could be found, there was demonstrated the skiametric acceptance of from 0.5 to 1 diopter of additional convex lens before the initial neutral shadow was obtained at the 13 inch fixation-observation distance. These observations relative to lag of accommodation, as I called it, have been substantiated by other investigators. Normally, therefore, the dynamic skiametric findings, with fixation and observation at the reading distance, will exceed the static retinoscopic findings by about three-quarters of a diopter as an average value. If the dynamic skiametric findings should exceed the static determinations by more than 0.5 to 1 diopter in conditions of emmetropia or hyperopia, or be decreased by more than a like amount in myopia, there is objective evidence of one (or more) of the following: (1) static undercorrection of hyperopia or overcorrection of myopia, (2) spasm of accommodation, (3) subnormal, ill-sustained, or insufficient accommodation, (4) presbyopia, (5) lack of harmony in, or interference with, the associated functions of accommodation and convergence by reasons of insufficiency of innervational resources.

Dynamic skiametry is primarily, although not exclusively, an objective method of quantitatively estimating the *accommodative* requirements. It is the only objective method at our disposal for investigating the ocular functions as they perform at close range, for it enables us to examine the function of accommodation in all its phases, either when working independently of the convergence or when operating in association with convergence.

Significance of Neutral Shadows and Reversal of Shadows in Dynamic Skiametry

In 1920, in the volume on Dynamic Skiametry I stated: "The value of the corrections obtained at any fixation point (observation-fixation distance being the same), when reversal of shadow is obtained, is *not* a measure of the *accommodative need* in order to correlate the functions of accommodation and convergence, but is a measure of the *negative relative accommodation.*" Dynamic skiametry, when practiced to the point of reversal, gives data objectively regarding the amount of plus lens that can be added, convergence remaining unaltered. However, this statement is far from implying that the demands on the innervational sources (accommodative and fusional) of convergence are not changed. In other words, it is an objective method for obtaining an answer to the question: By how many diopters can the accommodation be inhibited, the convergence remaining constant, in the amount requisite for the fixation distance? Subjectively, the analogue of these data consists in the determination of the values of the plus lenses which can be added, binocular single vision being maintained, until the letters on a suitable test type commence to blur. In emmetropia, with fixation at a distance of 13 inches, a negative relative accommodation of 2 to 2.5 diopters is found in general through the use of the subjective method. The dynamic skiametric method, with an observation-fixation distance of 13 inches, when carried to the point of reversal, gives values about 1.5 to 2 diopters greater than the static binocular findings. In summary, I believe that the dynamic skiametric findings at the *first neutral shadow*, due allowance being made for a lag of accommodation of 0.5 to 0.75 of a diopter, are a measure of the *accommodative assistance* that is requisite and that dynamic skiametric data, carried to the point of *reversal* of shadow, constitute an objective method of finding the *negative relative accommodation* or, in other words, the inhibition of accommodation under the conditions of convergence existent for the distance of fixation chosen for the test.

Tait has given us the results of his investigations in a paper concerning a quantitative system of skiametry in which he has attempted to correlate lag of accommodation, exophoria, accommodative convergence, and convergence accommodation with the findings of dynamic skiametry as practiced by his technic. He has summarized his results in the conclusions:

1. "That there is a definite relative range of accommodation or lag of accommodation for any given fixation as found by Sheard." 2. "That

this negative range has a different value according to the technique used. Its greatest expression in objective work can be obtained by the use of the 'fogging' technique." 3. "That the negative range of accommodation is prevented from being total for the fixation distance by some positive accommodation stimulated by the convergence for the point of fixation." 4. "That this positive relative accommodation or convergence accommodation can be measured by the accommodative convergence found under corresponding conditions. Apparently this is true association innervation and operative either way."

Skiametric Methods of Determining the Monocular and Binocular Amplitudes of Accommodation

In 1917 I presented an application of the principles of dynamic skiametry to the determination of the values of monocular and binocular amplitudes of accommodation through the objective measurement of the monocular and binocular punctum proximum, respectively. It is well known that the punctum proximum is the closest distance of distinct vision and is obtained through the maximal exertion of accommodation. In the objective determinations, by reason of the presence of the lag of accommodation and other practical difficulties which may arise, I have advocated the practice of using a small-sized target carrying a vertical row of 12-point or 14-point letters. The full static corrections or reading corrections in cases of presbyopia are worn by the person under examination. The test object is drawn toward the eye by the subject of the test and located initially at such a distance that the letters are easily read and not blurred. To the examiner stationed at, say, 18 inches, the skiascopic reflex will show, in normal conditions, an "against" or myopic condition, indicating that the examiner's eye is too remote from the point which is optically conjugate to the retina of the observing eye fixating the test object. The examiner then approaches the eye until he obtains the position of the neutral shadow. The test object is then to be brought still closer to the eye and the skiascopic neutral shadow again located. This procedure is repeated and the test object is drawn toward the eye and the closest distance at which the skiascopic neutral shadow is found and maintained, when converted into diopters, gives a value of the amplitude of accommodation. A report of inability on the part of the subject to see the letters distinctly is of no significance in the test; the continued attempt to read and decipher, however, is vital since the maximal exertion of accommodation is desired. The measurement of the distance between the eye under test and the location of the closest point for a neutral shadow gives the apparent rear point and from these data the range and amplitude of accommodation may be obtained.

The determination of the binocular amplitude of accommodation by dynamic skiametric methods is fundamentally the same as in the monocular procedures. In the binocular test the eyes are converging to, or fixating binocularly, if possible, the vertical row of letters or other fixation target employed. The examiner can determine the distance at which neutral shadows are obtained in each eye for any given position

of the objects fixated and can ascertain, by the measurement of the nearest distance at which neutral shadows are obtained and maintained as the fixation target is moved closer to the eyes, whether the binocular amplitude is less than, equal to, or greater than, the monocular amplitude. Furthermore, by monocular and binocular tests, data can be acquired concerning the equality or inequality of the accommodative amplitude in the two eyes and, in cases of marked anisometropia, such as a hyperopic condition in one eye with myopia in its mate, the examiner can determine the distances at which each eye, in turn, undertakes the functions of distant and close vision. In summary, these objective or skiametric methods of obtaining data are of value in finding the range and amplitude of accommodation in children and illiterates, in conditions of presbyopia, subnormal accommodation, inequality of accommodation, and in amblyopic conditions in which the examiner may be uncertain whether accommodation is still active for the reason that subjective tests may be unreliable because of markedly reduced visual acuity.

Subjective Determinations of the Monocular and Binocular Amplitudes

It seems unnecessary in these considerations to present technics and procedures in the determination of amplitudes of accommodation. As a selection from the various subjective tests, I shall present briefly the methods and conclusions of Duane. He recommends the use of a fine black line, about a quarter of an inch in length, engraved on a suitable white card, which can be moved along a modified Prince rule. When the line begins to blur, its distance from the anterior focal point of the eye is read from the scale. In 1922 Duane reported the results of his investigations concerning maximal, minimal, and average monocular amplitudes of accommodation in relation to age. In passing, let me take, as an illustration, certain data from the writings of Duane. At the age of thirty years, the maximal accommodation was found to be 10.8 diopters and the minimal value 6.5 diopters—a spread of about 4 diopters. The "blur point" distance, therefore, varied from 9.2 cm. to 16 cm. in monocular determinations of amplitudes of accommodation of normal individuals presumably possessed of comfortable vision. All those who are interested in the practical phases of ocular refraction are reminded again of the fact that there is a spread of values in normalcy and that no one test or set of data determined through its use is sufficient unto itself. The solution of ocular problems lies in the correlation of various data concerning accommodative and convergence demands and reserves at both distant and near points of fixation and focus.

From his investigations, Duane concluded: 1. "The binocular amplitude of accommodation will be regularly higher than the monocular value. 2. The binocular exceeds the monocular by amounts varying from 0.25 to 1 diopter. 3. When the monocular value exceeds that of the binocular, we may be sure of muscular imbalance. 4. The accommodative surplus in binocular vision is apparently due to a convergence action which induces an extra accommodative effort which is impossible when one is not converging binocularly."

Positive and Negative Relative Ranges and Amplitudes of Accommodation

During the past fifteen to twenty years, I have written, in various books and magazine articles, statements to the effect that data regarding the positive and negative relative accommodations and the positive and negative relative convergences are obtained readily through the use of (1) concave and convex lenses, and (2) prisms, base out and base in, respectively, for any chosen distance of fixation or focus. In routine practice it is generally sufficient to obtain such data with fixation at 6 meters and 33 cm., respectively. In the volumes on Dynamic Ocular Tests and Dynamic Skiametry, I directed the reader's attention to ways and means of obtaining data concerning the positive and negative portions of accommodation, both monocularly and binocularly and at various distances of focus; the character and sizes of test objects, and germane data; together with a discussion of the sources of error, points of advantages, and likely reasons for disagreements in the data obtained by various methods.

In more recent years, during which there has been a deeper and more widespread interest in the application of methods for the investigation of convergence and accommodation, there has arisen, through the writings and teachings of others, the belief that I have advocated large-sized letters both in distant and near tests for the determination of positive and negative accommodation and convergence. In 1917 I wrote: "In theory, then, all we need to do is to seek the strongest concave lens through which an eye still sees distinctly (just a definite blur) at a long distance and this lens will give the maximum of *dynamic* refraction of which the eye is susceptible, as advocated by Landolt. . . . In practice, then, the patient is provided with the minimum concave or maximum convex lenses, together with the cylinders, which will afford V = 10/10 as nearly as possible. In this concave-at-distance method the writer usually selects the V = 8/10 as a basis for the limiting value in the distinct-distant vision test." With reference to the tests at the reading distance, which were presented and discussed at the same time, I wrote: "The writer ordinarily uses number 2 Jaeger type (V = 0.50 D) held at 13 inches . . . Minus spheres, beginning in general with a —1 or —1.5 diopter glass, are then inserted in the trial frame or turned up in the lens battery in connection with the phoro-optometer until the minus lens has been inserted through which the number 2 Jaeger type is just barely readable." Some of the terms and expressions, such as "concave-at-distance" and "concave-at-near," have been deleted and considerable definiteness has been contributed to the expressions "just barely readable" and "blur-out points."

Since it may not be possible to obtain normal visual acuity either with or without correcting lenses, I believe that the simplest and most satisfactory procedure is to instruct the person under test to fix the attention on the smallest letters that can be read and to state when the letters are blurred. To blur means to "obscure by making confused and uncertain in form or outline; make indistinct and confused" (Webster's Dic-

tionary). Distinctness and details of form are possible only when the image of the fixated object is correctly focused on the retina. Hence, visual blurring will occur when the image is formed either in front of or behind the retina. Obviously, the retinal image, when not properly positioned, will cause indistinct or blurred vision irrespective of the size of object used or of image formed, but this indistinctness and blur may be ascertained more easily and definitely when the limiting values of ocular resolution are used.

However, the fundamental philosophy underlying all of these tests remains the same; the development of methods and the improvements in technic have contributed in large measure to the exactness of execution in modern ocular refraction.

Many years ago Donders stated the important principle that "The accommodation can be maintained only for a distance at which, in reference to the negative part, the positive part of the relative range of the accommodation is relatively great." Also, it may be accepted as a fundamental principle that any ocular function should be investigated under conditions of activity (stimulation) or quiescence (inhibition) which conform to the physiologic function under consideration. In other words, static refractive tests should disclose refractive errors and, when corrected, little if any accommodation should be required for distinct distant vision. Dynamic tests involve activity of function; normally accommodation is demanded for distinct vision at close points. The same type of question arises in this connection as in the consideration of the demands on convergence: Can the accommodative requirements be met with comfort? The answer to this question, in large measure, lies in the determinations of the values of the positive and negative relative accommodations and in the amplitude of accommodation obtained by various objective and subjective methods, both monocularly and binocularly.

A Citation of Data Regarding Relative Accommodation

If, for example, a person is accommodating for and converging to a point at 33 cm. distance and +3.50 D.S. can be added binocularly before the test letters become blurred, evidence is furnished that practically (although not mathematically exactly) 3.5 diopters of accommodation has been relaxed or inhibited while convergence remains constant irrespective of the character or sources of the innervational convergence. Accommodative convergence will be decreased normally somewhat in proportion to the suppression of accommodation. Therefore the positive fusional convergence demands will be increased normally and these increased demands must be taken care of by the positive fusional convergence in the interests of binocular single vision.

If, on the other hand, —1.50 D.S. can be added binocularly before the test letters become blurred, practically (although not mathematically exactly) 1.5 diopters of accommodation have been stimulated into activity while convergence remains constant for the point of fixation. In this case, accommodative convergence will be increased normally through the increase of accommodation, and, therefore, the demands on the posi-

tive fusional convergence will be decreased normally. Again, if accommodative overconvergence should be elicited, binocular single vision would be maintained through negative fusional convergence. Since negative fusional convergent response would not be expected in such a condition (because it is not sound doctrine, physiologically, to have concomitant innervational stimulation to, and muscular activity of, both internal and external rectus muscles), it is logical to conclude that the limitation to the binocular acceptance of minus lenses to the point of blur may be conditioned, in part at least, on the amount of accommodative convergence associated with the act of accommodation. These few statements, inserted by way of discussion, should cause each and every one to be cognizant of the many possible interrelationships between accommodation and convergence and to bear in mind that any binocular relative accommodative tests afford data concerning the accommodative stimulation or inhibition as dependent on accommodative convergence, fusional convergence demands and reserves. For such reasons, therefore, I have advocated not only the determination of the binocular findings but also the equally important data concerning the monocular positive and negative ranges of accommodation, the point of focus being 33 cm., since the monocular additions of plus and minus lenses do not involve activity or inhibition of accommodation associated with the maintenance of binocular single vision. The dissociation of the eyes does not prevent convergence responses of certain types and probable amount but it does prevent a limitation of the accommodative functions, under stimulation or inhibition, dependent on the association of the functions of convergence and accommodation. A comparison of the data obtained with monocular and binocular fixation and focusing often affords information regarding accommodative needs per se and accommodative needs and requirements as influenced by or limited by the convergence requirements which are maintained in the act of binocular single vision.

Let us return to the specific data cited, namely, 3.5 diopters of accommodative inhibition or lenticular substitute, optically considered, for accommodation, and 1.5 diopters of positive accommodative response, the fixating and focusing points being 33 cm. Can *comfortable distinct* vision be maintained? Or, in terms of Donders' dictum, is the positive part of the relative range of accommodation sufficiently great with reference to the negative part? In answer to these questions, I believe that extensive research regarding comfortable vision has demonstrated that the positive range of relative accommodation must at least be equal to the negative portion. Normal findings at the reading distance may be expected to be from —2.25 to —2.50 diopters (positive relative accommodation) and +2.00 to +2.50 diopters (negative relative accommodation). Such a statement, however, does not imply that the exact amounts specified must be obtained to be considered normal, but indicates the values of the expected findings as determined by the examination of hundreds of cases. Therefore, blur tests disclosing the binocular acceptance of —1.50 D.S. and +3.50 D.S., respectively, indicate (1) the

necessity of accommodative assistance, as O.U. +1.00 D.S., (2) the possibility of an inherent accommodative convergence excess, and (3) the possibility of low negative fusional convergence. The further analysis of the case must be based on the monocular amplitudes of accommodation, the total accommodative amplitude, and data regarding demands on convergence and convergence reserves.

Illustrative Data

A few illustrative cases must suffice to emphasize the importance of these discussions concerning both subjective and objective monocular and binocular tests of the amplitudes of accommodation and of the positive and negative relative accommodations, respectively. The data regarding accommodative ranges and amplitudes are not sufficient, in and of themselves, to warrant a final prescription without a consideration of data regarding the demands on and reserves of convergence. However, in certain instances, final prescriptions may be indicated and the reader is to assume that the convergence liabilities were adequately met and the convergence reserves ample.

Case 1. *Normal monocular and binocular accommodative amplitudes.* A woman, aged twenty-five years. Static skiametry, O. U. +1.00 D.S. Dynamic skiametry, fixation and observation at 13 inches, O. U. +1.75 D.S. in order to obtain neutral shadows. Subjective tests, O. U. +1.25 D.S., V = 20/20 binocularly. Monocular near point, reading number 2 Jaeger type (V = 0.50 D.) through distance corrections, indicated a punctum proximum of 5 inches (amplitude of accommodation, 8 D.); the binocular test gave a near point of 4 inches (10 D. of accommodation). With fixation and focus at 13 inches, hence requiring 3 diopters of accommodation to see distinctly, the subjective monocular positive and negative amplitudes were 5 D. (measured by —5.00 D.S. with definite blur) and 2.5 D. (measured by +2.5 D.S.), the binocular static corrections being worn. The positive and negative relative accommodations were 5.5 diopters and 3 diopters, respectively. The objective (skiametric) monocular accommodation test indicated, for each eye, 7 diopters; the binocular findings gave 8 diopters as the maximal amplitude of accommodation. Other data and tests regarding demands on, and reserves of, accommodation not indicating to the contrary, O. U. +1.25 D.S. would be prescribed.

Case 2. *Presbyopia.* The subjective findings, in excellent agreement with the static skiametric measurements, gave, in the case of a woman, aged fifty-eight years, normal or standard acuity with O. D. +1.75 D.S. ⌒ —1.25 cyl. ax. 180 and O. S. +2.00 D.S. ⌒ —1.00 cyl. ax. 180. Dynamic skiametric examinations at 16 inches disclosed O. U. +4.00 D.S. ⌒ —1.25 cyl. ax. 150. The objective accommodative tests, the statically determined corrections being worn, demonstrated a monocular near point of 20 inches, or the equivalent of 2 diopters of accommodation, while the binocular objective test showed 16 inches, equivalent to 2.5 diopters, as the near point. Therefore, for reading purposes at

16 inches, allowing the patient to retain one-half the available amplitude of accommodation in reserve (the accommodative amplitude being practically 2 diopters), she was given an additional O. U. +1.75 D.S.

In the particular case I have cited, I find in my records data relative to the demands on and reserves of convergence which, in résumé, showed distance reactions of 1Δ exophoria with positive and negative fusional reserves of 8Δ and 10Δ, respectively; at the reading distance, under dissociation tests, an accommodative exophoria of 20Δ, thereby indicating the total absence of convergence directly associated with accommodation. The positive fusional reserve (blur point) was 11Δ and the negative fusional reserve was 23Δ. These data indicate the necessity of the incorporation of prisms in the reading glasses (O. U. 3Δ, base in) and orthoptic training looking toward the development of positive fusional convergence.

Case 3. *Unequal monocular amplitudes of accommodation.* A man, aged twenty-one years; headaches; cannot read with comfort for any length of time; eyes extremely sensitive to light. Subjective static findings were O. D. +0.75 D.S. ⌒ —0.37 cyl. ax. 180, the visual acuity being equally good and 20/20 in each eye. Monocular objective accommodation tests, the distance corrections being worn, disclosed the punctum proximum at 5 inches for the right eye, or an amplitude of 8 diopters, and corresponding values of 4 inches and 10 diopters in the case of the left eye. The monocular subjective accommodation tests corroborated these findings. A spasm of accommodation was suspected, the cause without doubt being disclosed by tests which revealed a high positive fusional demand and relatively low convergence reserves. Excessive accommodation, with its accompaniment of accommodative convergence, enabled binocular single vision to be obtained but maintained only with discomfort. Treatment consists in the giving of the lenticular corrections combined with prisms, base in, and fusional training.

Case 4. *Amblyopia.* In the case of a man, aged thirty years, the static skiascopic findings were O. D. +3.00 D.S., O. S. +5.25 D.S. Dynamic skiametry disclosed O. D. +3.75 D.S. and O. S. +6.50 D.S. for initial neutral shadows. Subjective static findings gave O. D. +2.50 D.S., V = 20/20 and O. S. +4.50 D.S., vision in this eye being improved from the counting of fingers to V = 2/10 with correcting lenses. The monocular objective accommodation tests showed that the right eye had 4 D. of accommodation and that the punctum proximum of the left eye was at 20 inches, indicating 2 D. of accommodation. From 8Δ to 10Δ of esophoria were found with distant fixation, the lenses determined by the subjective static findings being worn. No satisfactory tests could be made on the relationships between accommodation and convergence at the reading distance. The data show, however, the possibility of producing marked improvement in the vision of the left eye because (1) the correction of the hyperopic error produced an appreciable improvement in vision, and (2) there was objectively determined evidence

of accommodative innervation and lenticular changes, under this innervation to the ciliary muscles, of 2 diopters.

Case 5. *Anisometropia with fair range of binocular accommodation.* A girl aged ten years. Static skiascopic findings determined as O. D. +3.25 D.S. ⌒ —5.00 cyl. ax. 10, O. S. +0.50 D.S. ⌒ +0.50 cyl. ax. 90. Subjectively, O. D. +2.50 ⌒ —4.75 cyl. ax. 10 gave V = 8/10, while the static correction before the left eye afforded V = 10/10. The monocular objective accommodation, wearing the subjectively determined findings, indicated O. D. 5 diopters and O. S. 8 diopters of accommodative amplitude. The near points by subjective methods were O. D. 7 inches and O. S. 4 inches. Phoria tests disclosed 4Δ exophoria, while dissociation tests at 13 inches showed an accommodative exophoria of 12Δ, thus indicating an accommodative convergence of 11Δ, the interpupillary distance being 63 mm. The maximal positive relative convergence that could be obtained at 13 inches was 10Δ. The patient was given the static corrections with a small amount of prism, base in, for constant wear; prism, base out, treatments and intermittent accommodative stimulation were prescribed. This program was carried out with the result that after five months the accommodative amplitude of the right eye had been raised from 5 D. to 6.5 D., and the positive fusional convergence had been increased about 5Δ.

Case 6. *Excessively high dynamic findings with low amplitudes of accommodation.* This case illustrates the importance of the tests on relative and total amplitudes of accommodation, the pronounced difference between the static and dynamic findings, and the considerable variation between the monocular and binocular values of accommodative amplitude.

A girl, aged twelve years, complained of frontal headaches and inability to read in late afternoons and evenings. Static skiascopic tests evidenced O. U. +1.25 D.S. Dynamic skiametric findings for initial neutral shadow were O. U. +3.00 D.S. Binocularly, under subjective tests, O. U. +1.00 D.S. were accepted with V = 8/10 to 10/10. With the static corrections, distant tonicity tests evidenced 4 esophoria and at 13 inches, under dissociation tests, 4Δ of excessive convergence were disclosed, indicating an accommodative exophoria of zero. The objectively determined monocular accommodative amplitude was 3.5 D. for each eye; the binocular tests gave 5.5 diopters. The subjective accommodative tests disclosed the fact that the patient could not read monocularly number 2 Jaeger type at 13 inches, through the static corrections, although this type could be read binocularly with difficulty. With a correction of O. U. +2.00 D.S. the number 2 Jaeger type could be read at 10 inches. The positive and negative relative accommodations, O. U. +2.00 being worn, with fixation and focus at 13 inches, were 1 D. (minus lenses to blur) and 3 D. (plus lenses to blur), respectively. Positive and negative relative convergences were 24Δ and 7Δ, respectively. This case clearly evidences involvement of the function of accommodation, overstimulation innervationally with lack of muscular response. Such conditions may

occur by reason of focal infection, chlorosis, syphilis, and so forth. From the refractive standpoint, the condition is to be classified as accommodative insufficiency and the optical treatment should consist of (1) prescription of both near and far corrections, such as O. U. +2.50 D.S. for close work, either as two pairs of glasses or in bifocals; (2) intermittent stimulation of the accommodation (using minus spheres) until the accommodative reserves are increased; (3) convergence exercises and stereoscopic training.

Case 7. Binocular amplitude of accommodation less than the monocular amplitudes. A man, aged twenty-five years. Static skiascopic findings, O. D. +0.75 D.S. ⌒ +1.00 cyl. ax. 90 and O. S. ⌒ +0.75 D.S. ⌒ +1.50 cyl. ax. 90. These findings afforded the best visual acuity possible, V = 8/10. Dynamic skiametry disclosed practically the same findings; if anything, a trifle *less* spherical power for initial skiametric neutralization. The monocular objective accommodative tests, the patient wearing the statically determined corrections gave amplitudes of 5 diopters for each eye; the binocular tests disclosed a punctum proximum of 12 inches, or amplitudes of 3.3 diopters. Additional tests showed (1) a tonic exophoria of 6Δ, (2) an accommodative exophoria of 20Δ (indicating an accommodative convergence of 4Δ, since 18Δ +6Δ —20Δ = 4Δ), (3) a positive fusional convergence reserve of 8Δ with fixation at 13 inches, (4) an adduction with distance fixation which is nil, indicating that the patient is just able to secure binocular single vision, and an abduction of 18Δ. We have evidence in this case of low monocular amplitudes of accommodation, a still lower binocular amplitude of accommodation, a high demand on fusional convergence to maintain binocular single vision, and a low positive fusional convergence reserve. In general, treatment in such cases should consist of (1) the prescription of the static findings with the incorporation of prism, base in, equal to about half of the exophoria disclosed by the phoria tests, (2) stimulation of convergence through the use of prisms, base out, and (3) the possible use of minus lenses to stimulate accommodation.

REFERENCES

Lesser, S. K. Fundamentals of Procedure and Analysis in Ocular Examinations, 3d edition, 1934, 111 pages. Published by the author, Fort Worth, Texas.

Also

1. Atkinson, T. G.: Ocular muscles and fusion. Chicago, The Professional Press, 1933, 192 pages.
2. Atkinson, T. G., and Woll, F. A.: Dynamic skiametry, its theory and practice. Chicago, The Professional Press, 1928, 192 pages.
3. Davis, A. E.: Refraction and accommodation of the eye. Am. Encyclopedia of Ophth. 14:10921-11177, 1919.
4. Dobson, Margaret: Dynamic retinoscopy. England, Oxford University Press, 1931, 56 pages.

5. Dobson, Margaret: Binocular vision and the modern treatment of squint. England, Oxford University Press, 1933, 107 pages.
6. Duane, Alexander: Studies in monocular and binocular accommodation. Am. Jour. Ophth. 5:865-877 (Nov.), 1922.
Binocular accommodation. Arch. Ophth. 51:396-397, 1922.
7. Jaques, Louis, and Crow, George: Applied refraction, with special reference to the blur-out point technique. Los Angeles, H. R. Day Publishing Co., 1934, 123 pages.
8. Koch, C. C.: A routine refraction. Bulletin Educational Congress of American Optometric Association, 1928, 134 pages.
9. Needles, W. B.: Ocular muscles. Dept. of Education, Amer. Opt. Assn., 1919, 34 pages.
10. Nott, I. S.: Accommodative convergence and fusion convergence. Southbridge, Mass., Am. Optical Co., 1928, 34 pages.
11. Pascal, J. I.: Modern retinoscopy. London, Hatton Press, 1930, 279 pages.
12. Peckham, R. M.: The modern treatment of binocular imbalances. New York, Shur-On Standard Optical Co., 1928, 184 pages.
13. Peckham, R. M.: Squints and heterophorias. Rochester, New York, published by the author, 1931, 368 pages.
14. Peter, L. C.: The extra-ocular muscles. Philadelphia, Lea and Febiger, 1927, 294 pages.
15. Phoroptor and its use in ocular refraction. American Optical Co., 1928, 213 pages.
16. Robinson, S. H.: Oculo-prism treatment. Chicago, Professional Press, 1924, 188 pages.
17. Sheard, Charles: Dynamic ocular tests. Columbus, Laurence Press, 1917, 213 pages.
18. Sheard, Charles: Dynamic skiametry and methods of testing accommodation and convergence. Chicago, Cleveland Press, 1920, 108 pages.
19. Sheard, Charles: Ocular accommodation. Department of Education, American Optical Assn., 1920, 77 pages.
20. Sheard, Charles: Zones of ocular comfort. Proceedings American Academy of Optometry, 3:113-129, 1928.
21. Skeffington, A. M.: Ocular diagnosis. St. Louis, The Graduate Clinic Foundation.
22. Swann, L. A.: The ocular muscles. London, Hatton Press, 1932, 208 pages.
23. Tait, E. F.: A quantitative system of dynamic skiametry. Proceedings American Academy of Optometry, 3, 1928, pages 131-161.
24. Walker, R. N.: A method of optometric quantitative analysis by certain interpretations of the findings upon a routine examination. Jour. Optometry, 11:1-27, 1934.

AN EXPERIMENTAL INVESTIGATION OF THE NEGATIVE-FUSIONAL CONVERGENCE AMPLITUDE*

William J. Tait, B. S., M. A., O. D.
Philadelphia, Pa.

A careful perusal of both Optometrical and Ophthalmological literature yielded several case-studies reported by various investigators, in which they had been successful in developing the fusional convergence amplitude, both in a negative and in a positive direction, by the employment of orthoptic calisthenics.

However, the writer has not been able to achieve such desirable results with his own private cases, to whom he has given considerable prismatic exercise without any appreciable increase or decrease in the abductions or the adductions, beyond what would be allowable for the experimental error of the prisms that were used to determine the relative amounts of innervation supplied to the extra-ocular muscles.

In an attempt to reconcile the existing inconsistencies that were evident when a comparison of data was made, it was decided to investigate the problem more thoroughly in the research clinics of the Pennsylvania State College of Optometry. Here it would be possible to conduct the investigation under standardized conditions and to select the subjects who could be thoroughly trained both in observation and introspection, since the average patient is not fitted either by training or by experience to give reliable judgments, free from possible errors of intention or bias.

This paper is the beginning of a series of similar investigative procedures with the purpose of ascertaining what can be accomplished in the field of ocular myology, under conditions so controlled that they can be repeated and verified by other experimenters without any quibbling over the methods employed or the technique of instrumentation. With research material that is collected under specified methods of standardization and instruction, Optometry will then be better able to contribute something that is worthwhile to the archives of science. At the present time there are entirely too many generalizations and

---

*An abridgement of the material presented before the American Academy of Optometry at Baltimore, December 19, 1933.

arm-chair deductions, without previous adequate experimental background upon which to philosophize. A considerable portion of the current literature sadly lacks complete details of the experimental procedures utilized in various investigations, and if the complete details are known, they are not fully treated and reported. Science can be defined as a knowledge of facts, laws and proximate causes, gained through, and verified by, exact observation and correct thinking. In every scientific investigation an exact definition of the problem must be given, together with the source of subjects, a description of the technique employed, and a statistical presentation of the reliability, validity and the variability of the obtained data wherever possible. The main object of any scientific observation is to ascertain the truth and then to follow fearlessly in its path.

This paper is mainly concerned with the possibility of developing the negative fusional convergence amplitude. By the term negative fusional convergence is meant "The innervation supplied to the extra-ocular muscles in their endeavor to maintain single binocular vision of the fixation-object, thereby preventing a homonymous diplopia from ensuing. The amplitude of fusion in a negative direction is measured by the amount of prismatic power, placed base in, that can be overcome immediately prior to diplopia.

At my disposal were several different types of instruments by which orthoptic exercises could be administered, but it was decided to employ the Kratometer in order to be consistent with the technique and methods suggested in the earlier studies. From the neuro-physiological viewpoint, a rhythmic deflecting of the bi-macular images out into the peri-macular fusion area would seem a much more efficient method of developing a greater reflex activity and integration of the neural pathways, than by simply gliding the foveal images without any reversal of direction. It was thought that there would be less chance for adaptation to take place with a vacillating image. A sameness of stimulation causes a decline in the excitability of the sensory nerves and receptor organs, but this is not, however, to be confused with fatigue. Fatigue is due to an accumulation of the end and intermediate products of metabolism, particularly the acid-metabolites which interfere with the propagation of nervous impulses. At the present time there is no physiological explanation for the phenomenon of adaptation. Sensory adaptation must be properly evaluated, as it is to be found in the human eye and it increases as we approach the periphery where it is necessary for an object to be constantly in motion or it will rapidly disappear from view.

Subjects:

After a careful consideration, four senior internes, Lyle M. Cruse, Charles K. Doland, Arnold C. Kight, and Arthur R. Neale, from the College Clinics, were selected to act as subjects. They were chosen on a basis of scholastic standing and natural aptitude toward scientific research. Their ages ranged from twenty-five to twenty-seven years,

and they were apparently enjoying normal health. The subjects were carefully refracted and fully corrected for any refractive defects. Wearing the corrections, they all exhibited 20/20 or better visual acuity.

The nature of the problem was carefully explained to them in detail and the experimental procedure was carried out several times by each individual to insure a uniformity of and conformity to method. It was impressed upon the subjects that regardless of the outcome of the experiment, whether the results were positive or negative, there would be a definite contribution to human knowledge.

Apparatus:

Two Genothalmic Kratometers with prism slides placed to give base-in exercise were used. Fixation was at a 1/3 M. upon a 4 m/m black letter E, printed upon a white card. This near-point fixation was small enough to subtend an angle of less than 3 degrees at the nodal point. Objects larger than this have their corresponding images outside of the foveal limits and in order to perceive their details, the eyes would have to search, so to speak, over the surface of the object, a condition that might possibly vitiate the results. The same fixation-object was used for the near-point duction determinations.

A Maezel Metronome, regulated to tick 56 times a minute, permitted the prism slides to be changed at a constant rate. The ductive power of the eyes was measured daily, before and after treatment, by means of rotary prisms which form an integral part of the De Zeng phorometer, manufactured by the American Optical Company. Fixation for distance was upon a 20/200 letter E and at near upon the 4 m/m E, previously described. It might be mentioned that in ascertaining the ductions the rotary prisms were turned simultaneously and at an approximate rate of 80 prism diopters per minute. The intensity of illumination before each eye was kept constant at 25 foot-candles and was measured frequently by means of a "Sight-Meter," an instrument recently placed upon the market by the Weston Instrument Company. The last two mentioned precautions play an important role in determining variation differences in the ductions in a given individual.

Procedure:

As a control, and in order to rule out any chance fluctuations that might affect the duction reserves, the fusional convergence was measured twice a day, for an entire week, prior to the inauguration of treatment. In addition to obtaining the horizontal ductions for near and distance, the 'phorias and reversions to fusion were likewise noted during this period. For the first two weeks each subject received four treatments per day, of ten minutes' duration. As the obtained results disclosed little change and as the subjects experienced no appreciable fatigue, it was decided to increase the length of treatment from ten minutes to twenty minutes, during the remaining two weeks. Subsequent to the treatment period, a final control week was included, and the values averaged so as to give a means for comparison with those

Subject: Lyle M. Cruse.

Experimenter: Arnold C. Kight.

Control Week (averages)	Distance			Near		
	Abd.	Add.	Phoria	Abd.	Add.	Phoria
First Week	5/3	10/7	ortho	17/13	9/7	7 exo.

Treatments	Abd.(dist.)	Abd.(near)	Peak
11/6/33	6/4	16/11	10
" 7 "	6/4	13/10	10
" 8 "	5/4	15/10	12
" 9 "	6/5	16/12	12
"10 "	6/5	17/13	12
" 13"	6/5	17/13	14
" 14"	6/5	14/13	14
" 15"	7/6	18/14	16
" 16"	6/5	17/13	16
" 17"	7/5	20/12	16
" 20"	7/5	16/13	16
" 21"	6/5	17/13	16
" 22"	6/5	17/10	16
" 23"	7/5	16/11	16
" 24"	7/6	15/13	16
" 27"	6/5	17/11	16
" 28"	6/5	18/12	18

Control Week (averages)	Distance			Near		
	Abd.	Add.	Phoria	Abd.	Add.	Phoria
Final Week	6/4	12/8	ortho	18/14	15/14	7 exo.

Pupillary Distance 66 mm.

Accommodative-Convergence: 12 P.D.(before) 12 P.D.(after)

Dr William Tait. Data. Figure One.

collected during the initial control run.

At the beginning of each daily treatment, the amount of abduction was also determined with the Kratometer and from the total amount necessary to produce diplopia, two prism diopters were deducted. This modified value was selected as the maximum limit of the exercising range, the other being zero. The positive prisms were never increased

Subject:Arnold C.Kight.

Experimenter:Lyle M.Kruse.

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
First Week	7/5	20/8	1 exo.	18/12	21/20	7 exo.

Treatments	Abd.(dist.)	Abd.(near)	Peak
11/6/33	8/7	23/17	10
" 7 "	8/6	22/16	10
" 8 "	8/6	21/16	14
" 9 "	8/7	22/15	16
"10 "	7/6	21/16	16
"13 "	8/7	21/17	18
"14 "	7/6	21/17	18
"15 "	7/6	21/17	18
"16 "	7/6	21/14	20
"17 "	7/6	19/13	20
"20 "	7/6	20/15	20
"21 "	7/6	21/15	20
"22"	7/6	20/15	20
"23 "	7/5	20/16	20
"24 "	7/6	23/15	20
"27 "	7/5	21/16	20
"28 "	7/5	21/19	20

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
Final Week	6/5	27/10	ortho	21/17	27/26	9 exo

Pupillary Distance 66 mm.

Accommodative-Convergence: 13 P.D.(before) 10P.D.(after)

Dr William Tait. Data Continued. Figure Two.

to the point of diplopia while the subject was receiving treatment. The purpose for doing this was to eliminate any possible expectancy on the part of the subject to anticipate the dual objects that would result if the prism power was carried to the breaking point, and at the same time we wished to duplicate as far as possible the previous work reported.

Subject: Charles K. Doland

Experimenter: Arthur R. Neale

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
First Week	8/5	28/10	1 eso.	14/12	16/9	4 exo.

Treatments	Abd.(dist.)	Abd.(near)	Peak
11/7/33	9/7	17/13	20
" 8 "	8/6	16/13	24
" 9 "	8/5	16/13	16
"10 "	7/6	16/12	20
"13 "	8/7	16/15	18
"14 "	8/7	16/17	20
"15 "	8/7	20/13	20
"16 "	8/7	17/14	20
"17 "	8/5	16/15	20
"20 "	8/7	16/15	22
"21 "	8/7	16/15	24
"22 "	8/7	16/13	24
"23 "	9/8	28/27	24
"24 "	8/7	21/18	24
"27 "	8/6	20/16	24
"28 "	8/6	18/15	24

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
Final Week	8/7	31/12	ortho	17/14	21/13	4 exo.

Pupillary Distance 63 mm.

Accommodative-Convergence: 13 P.D.(before) 14 P.D.(after)

Dr William Tait. Data Continued. Figure Three.

Theoretical Considerations:

Predicting an *a priori* neuro-muscular co-ordinating system we find that it is necessary for the individual so endowed, to learn how to use this mechanism. It has been indisputably established that ocular co-ordination, for the most part, develops during the first few years of one's life. Through performance and activation, a learning process is initiated which ultimately leads to a highly integrated and refined

Subject: Arthur R. Neale

Experimenter: Charles K. Doland.

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
First Week	8/6	51/46	3 exo	23/20	42/39	13 exo

Treatments	Abd. (dist.)	Abd. (near)	Peak
11/7/33	8/6	25/24	24
" 8 "	8/7	25/22	26
" 9 "	8/7	25/23	24
"10 "	8/7	25/21	24
"13 "	10/9	26/24	26
"14 "	9/8	26/26	26
"15 "	9/8	25/23	26
"16 "	8/7	27/25	26
"17 "	9/8	29/27	26
"20 "	9/8	28/26	26
"21 "	9/8	28/27	26
"22 "	8/7	28/27	26
"23 "	9/8	28/27	26
"24 "	8/7	28/27	26
"27 "	9/8	28/27	26
"28 "	9/8	27/26	26

Control Week (averages)	Distance Abd.	Add.	Phoria	Near Abd.	Add.	Phoria
Final Week	8/7	60+	3 exo.	29/27	44/40	15 exo.

Pupillary Distance 65 mm.

Accommodative-Convergence: 8 P.D. (before) 6 P.D. (after)

Dr William Tait. Data Continued. Figure Four.

response-mechanism. It is thought that this acquirement is at first accompanied by a certain amount of consciousness, but as the mental operations gradually become habituated, we find that consciousness proportionately disappears. From a physiological aspect, learning has as its basis, a modification of nervous tissue. An idea in consciousness, for example, leaves a certain imprint or trace which serves as a means to facilitate subsequent recall of a similar idea. How well we remember

depends upon the number and strength of the associational pathways that can be utilized when we desire to revive some past event. By a frequent use of these channels the permeability increases, thus permitting neural impulses to pass more easily over the inter-connecting neurones. The resistance that was noticeable during the initial learning period has lessened considerably, probably as the result of either a physical or chemical change taking place in the synaptical connections. The manner in which this lowering of resistance is brought about is not definitely known. One group of physiologists hold that neurobiotactic changes occur, in which the end-brushes of the axones and the dendrites are afforded a better physical approximation, thus narrowing the synaptical gaps.

This brief outline on the concept of the learning process was included because the essence of this experiment was based on this premise. Inasmuch as the construction of the instrument permitted a relatively small range of ocular movements, any kinaesthetic sensations present were not consciously experienced, therefore, our problem becomes one of sub-liminal learning in the absence of any consciousness.

When we apply base-in prisms before a subject's eyes, the retinal images of the object of regard are immediately deflected from the foveae to the adjacent nasal peri-macular areas. With the proviso that the prismatic power is less than sufficient to produce diplopia, there is an immediate reflex activity set in operation to innervate the extra-ocular muscles in such a fashion that the foveae are turned nasally to a position directly behind the displaced images. This physiological adjustment is accomplished by the intermediation of the negative fusional convergence, of which it is a function. It is only by stimulation of the peri-macular area that fusion efforts are induced. Ordinarily, the only type of convergence usable at the near point is that of fusional convergence, as Dr. Edwin Tait's recent studies[1] have shown. He is of the opinion that the accommodative-convergence, although it may initially assist in placing the intersected visual axes at the reference point, yet when the convergence is attained, the accommodative-convergence becomes potentially inactive. A crude analogy would make this approach comparable to the latent energy of a storage battery in which it is necessary to set up a certain situation before the latent energy of the battery is released. So it is with the accommodative-convergence which only becomes operative when the necessity arises, such as in the act of initial fixation or when the accommodation is made the dominant factor under dissociation in our 'phoria determinations.

Another point to be brought out is the fact that since the prism power is being increased in equal steps, the images will be thrown upon identical areas in the peri-macular regions with each accretion, and not increasingly farther and farther from the foveæ as a number of textbooks dogmatically state.

---

[1]Tait, E. F., A Reciprocal Reflex System in the Accommodative-Convergence Relationships. Amer. J. Psychol., Vol. XLV, pp. 647-662.

With a repeated stimulation, at regular intervals, of the same sensory surfaces, it was hoped that this situation would set in motion a sub-liminal learning process, either by increasing the number of functioning cones or by increasing the efficiency of those already in operation, through a better facilitation of the associative bonds. This would then lead to a strengthening of the response and with it an improvement in the fusional divergence amplitude.

Discussion of Results:

A comparison of the duction values before and after the training period, revealed some very interesting data. In the first place two of the subjects showed no change whatever in the abduction for distance. The other two subjects reacted by an increase and a decrease of one prism-diopter, respectively. Considering the near-point data, we find an abduction increase of from one to six prism-diopters. The real significant feature, however, is to be found in the adduction values. Taken as a group the four subjects showed a greater increase in the distance and near adductions than was evidenced by the abductive ascertainment.

It has repeatedly been stated that the tonus of a muscle can be increased only when the prism-apices are placed over the muscle or muscles in question. Contrary to expectations, this experiment raises a valid objection to the above promulgated belief.

We have advocated from time to time the placement of prisms base-in wherever a fatigue exophoria has been recognized. This procedure would relax the internal recti muscles and give the motor-nerve endings a physiological rest, thus permitting an absorption and further oxidation of the catabolic substances. We see, nevertheless, that there is a lack of change in the 'phorias in two cases while two of the subjects indicate an increase of two prism-diopters in the near exophoria, the distance imbalance remaining substantially the same.

Although we were not primarily interested in the size of the extra-macular fusion area which is determined by the reversion to fusion after diplopia was elicited, it is noticed that there is a general tendency towards a slight increase. It is conceivable to the writer that this pick-up point can show wide variations, even in the same individual, under disturbing factors such as fatigue, toxicity, and an inefficiency of the relatively few scattered cones in the vicinity of the peripheral retina.

Being cognizant of the fact that the fixation-object was not a suitable device for blurr-point analysis, yet there was reported a blurring of the fixated letter with increase of base-in prisms. The initial placement of the image on the peri-macular field caused a horizontal stretching of the E, almost to the point of distortion, but with the adjustment of the visual axes to place the foveae behind the image, this phenomenon disappeared and the object assumed its regular shape. However, when the total portion of the relative convergence was relaxed, the convergent-accommodative reflex upon further convergence relaxation, produced a corresponding accommodative inhibition, thus placing the eyes in a

status of anatomically uncompensated hyperopia with the image appearing more and more indistinct. This haziness persisted throughout the range of convergent-accommodation relaxation, when a final stretching of the object of fixation preceded the diplopia. It might be mentioned that convergent-accommodation as with its associate, accommodative-convergence, is not normally operative at the near-point, and it is only when we make the convergence the dominant factor that it becomes manifest. We can do this in either one of two ways: (1) by relaxing the convergence to the extent of its independence of accommodation, (2) or by inhibiting the accommodation with convex lenses while applying the system of dynamic skiametry developed by Dr. E. F. Tait. The blur-point showed a positive relation to the accommodative-convergence tie-up and those subjects who had the better accommodative-convergent connection as shown by a relatively lower physiological exophoria, indicated a smaller blur-point area. It might be emphasized that this blur-point was only observable at near and was not experienced by any of the subjects at distance which is to be expected, since practically all of the convergence relaxation for distance is relative convergence and it is not normally possible to relax accommodation beyond its far point at infinity.

A final observation that we commonly see, was the enlargement of the fixation-object with increased base-in prisms. This is a psychological illusion due to a relaxing of convergence. We have established a habit from past experience that with a given amount of convergence, a kinaesthetic sensation is produced as a result of stimulating the proprioceptive nerve-endings and receptors embedded in the extra-ocular muscles. The initiated impulses form certain impressions which are grouped in certain patterns, each pattern being associated with a different positioning of the visual axes of the two eyes. Our apperceptive background informs us that large objects do not have to be held as close to the eyes as smaller ones for observation. As convergence is relaxed, the fixation-target is mentally interpreted as being further away, and we, accordingly, perceive the letter E as being larger than it really is.

Summary:

1. A careful analysis of the data reveals that base-in prism calisthenics were more successful in increasing the neuro-muscular response of the adductive amplitude than in effecting any material change in the abductive reserve. This is contrary to the current conceptions.

2. That there is some positive indication of a convergent-accommodative association with the blur-point phenomena.

3. That a problem of this nature must be investigated with selected and trained subjects, ocularly and physically normal, and with a rigid control of existing external variables.

4. Because of an insufficient number of subjects, it is not the intention of the writer to attempt to formulate any authoritative statement regarding the rationale of base-in prism exercises. Nevertheless, since this experiment disclosed a lack of agreement with previous con-

ceptions, a satisfactory solution in this field points to the necessity for further research and for a more thorough consideration of the fundamental problems involved.

5. The work is to be continued in the Research Clinic of the Pennsylvania State College of Optometry. There it will be possible to employ various orthoptic instruments and ascertain the relative results with tri-dimensional fixation objects, circularly and spirally-moving objects, and emotion-producing objects. It is our hope to present, at a later date, a much more complete and precise report, together with a complete statistical analysis.

DR. WILLIAM J. TAIT,
1824 W. GIRARD AVENUE,
PHILADELPHIA, PA.

AMERICAN JOURNAL OF OPTOMETRY

Vol. 11 DECEMBER, 1934 No. 12

EDITORS

DR. CAREL C. KOCH
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

DR. JACK I. KURTZ
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

Original papers, scientific communications, clinical reports, society proceedings, books for review, and correspondence should be sent to the Editor, Dr. Carel C. Koch.

Annual Subscription, $4.00 in Advance, Canada and Foreign, $5.00.
Single Copies, 40c.

Copy of advertisements must be sent in by the tenth of the month preceding their appearance. Subscriptions, applications for single copies, communications with reference to advertising or other business should be addressed to the Business Manager, Dr. Jack I. Kurtz, 1501 Foshay Tower, Minneapolis, Minn.

Published Monthly by the
American Journal of Optometry Publishing Association.

The Journal has no objection to the reprinting by other magazines of any of its articles, provided such reprints are properly credited to the Amerian Journal of Optometry.

REFRACTIVE ERRORS IN CHILDREN

From an analytical study of the refraction records of 1,702 children examined between 1926 and 1933, H. McIlroy[1] makes the following classification: For the whole group, hyperopia accounted for 78.78 per cent (boys) and 76.90 per cent (girls). The corresponding figures for myopia were 20.07 per cent (boys) and 22.43 per cent (girls). Emmetropia accounted for 1.13 per cent (boys) and 0.66 per cent (girls).

The incidence of myopia over 5 D. in boys was 1.38 per cent and in girls 1.65 per cent. Moderate myopia (2-5 D.) occurred in 8.15 per cent (boys) and 8.06 per cent (girls) and low myopia (under 2 D.) in 15.54 per cent (boys) and 12.70 per cent (girls). The incidence of high hyperopia was 11.29 per cent (boys) and 7.18 per cent (girls).

In analyzing the 354 cases followed up for a period between 18 months and 4 years and a few for a longer period, the author found a decrease in hyperopia in 215 cases, an increase in myopia in 81 cases, no change in 21 cases, whilst in 39 cases the refraction had become less.

[1] Brit. Journal of Ophth., October, 1934.

From mathematical analysis it was argued that whilst the average increase in refraction was 0.26 D. per year for boys it was 0.30 D. per year for girls. The increase in refraction for hyperopes was the same for boys and girls, i.e., 0.26 D. and 0.27 D. per year. In myopia there was a definite sex difference, boys showed an increase of 0.47 D. per year and girls 0.59 D. per year.

The 39 cases showing a decrease in refraction were considered to be due to incomplete cycloplegia.

We question the explanation about the 39 cases which showed a decrease in refraction as being due to incomplete cycloplegia; we found from our experimental studies of refraction with and without cycloplegics that there are present in some cases certain physiological variations in the amount of the refractive error and this variation will be present regardless whether the eyes are refracted with or without a cycloplegic.

Sorsby, who made an exhaustive study of refractive conditions of several thousands of school children in London and followed up this same group for a period of from six to ten years, also found that in a large percentage of school children the amount of hyperopia is constantly decreasing. J. I. K.

* * * * *

THE MUSCLES OF THE IRIS AND THEIR ACTION

A very interesting case was reported by C. Behr[1] of the pupil reactions of a girl, age 16, who has a small circular hole in the iris due to a perforating injury which took place in early childhood. The hole involved several layers of the iris, and was situated slightly peripherally to the sphincter region. Under normal conditions the hole was circular and Behr studied the changes in the shape which occurred when the pupil reacted to drugs, accommodation or light. He interpreted these changes according to these considerations: If during the course of any pupilary reaction the hole maintained its circular shape, the sphincter and dilator muscles were held to act harmoniously (equivalent contraction of one and relaxation of the other). If the hole elongated into an oval with long axis lying radially it was concluded that the sphincter acted without active relaxation, or against the resistance of the dilator. An oval shaped hole with the short axis radial was interpreted as the effect of relaxation of the dilator without change in tone of the sphincter.

The accompanying table contains the author's observations during the various motor actions of the pupil:

Reaction to light.
Active contraction of sphincter.
Active relaxation of dilator.

[1]Arch. f. Oph., September, 1933.

Reaction to accommodation.
Active contraction of sphincter.
Passive dilator.

Psychic, sensory dilation.
Relaxation of sphincter at first.
Active contraction of dilator later.

Homatropine and cocaine.
Sphincter paralyzed.
Dilator unaffected.

Cocaine.
Sphincter somewhat restrained.
Dilator stimulated.

Physostigmine.
Sphincter stimulation.
Dilator unaltered.

J. I. K.

* * * * *

BENJAMIN FRANKLIN THE INVENTOR OF BIFOCALS

There have been a number of medals struck off in honor of Benjamin Franklin to commemorate his many accomplishments. The latest one is the Franklin Bifocal Sesquicentennial Medal. It was struck off by Bausch and Lomb from the design of the famous sculptor, Krilenyi, to celebrate the one hundred and fiftieth anniversary of the invention of bifocals.

Franklin was noted and beloved for his great achievements in many fields. He was a diplomat, statesman and scientist. At the age of 74 he was so popular in France that John Adams said, "Franklin's reputation was more universal than that of Leibnitz, or Newton, Frederick or Voltaire, and his character more beloved and esteemed than any or all of them."

In spite of all his accomplishments Franklin was greatly worried about his eyes and was constantly seeking a solution. When he found it he wrote to his friend, George Whately, on August 21, 1784: "Your eyes must continue very good, since you can write so small a hand without spectacles. I cannot distinguish a letter, even of large print, but am happy in the invention of double spectacles, which serving for distant objects as well as near ones, make my eyes as useful to me as ever they were. If all the other defects and infirmities were as easily and cheaply remedied, it would be worth while for friends to live a great deal longer."

Whately informed the distinguished English optician, Dollond, the inventor of the achromatic lens, about Franklin's invention. Dollond replied that such lenses will only serve for particular eyes but will not be of practical value for general use.

In May, 1785, Franklin replied to Dollond's statement as follows:

"By Mr. Dollond's saying that my double spectacles can only serve particular eyes, I doubt he has been rightly informed of their construction. I imagine it will be found pretty generally true, that the same convexity of glass, through which a man sees clearest and best at the distance proper for reading, is not the best for greater distances. I therefore had formerly two pairs of spectacles, which I shifted, occasionally, as in traveling I sometimes read, and often wanted to regard the prospects. Finding this change troublesome, and not always sufficiently ready, I had the glasses cut and a half of each kind associated in the same circle. By this means, as I wear my spectacles constantly, I have only to move my eyes up or down, as I want to see distinctly far or near. This I find more particularly convenient since my being in France, the glasses that serve me best at table to see what I eat not being the best to see the faces of those on the other side of the table who speak to me; and when one's ears are not well accustomed to the sounds of a language, a sight of the movements in the features of him that speaks helps to explain; so that I understand French better by the help of my spectacles."

The public in general and the profession of optometry in particular have much to be thankful for to Franklin for his industry and invention. The bifocal has proven to be a boon to mankind. J. I. K.

BOOK NOTICES

DISEASES OF THE EYE. Sir John Herbert Parsons, C.B.E., D.Sc., F.R.C.S., F.R.S., Consulting Ophthalmic Surgeon, University College Hospital; Consulting Surgeon, Royal London (Moorfields) Ophthalmic Hospital. Published by the Macmillan Company. Seventh Edition. 695 pages, 21 colored plates, 353 illustrations. $5.50. 1934.

This new, seventh edition of Parsons' Diseases of the Eye is larger and more complete than any of the editions or reprintings which preceded it. Several chapters have been completely rewritten and many new illustrations have been added. The book is arranged in eight complete sections as follows: (1) Anatomy and Physiology; (2) Examination of the Eye; (3) Diseases of the Eye; (4) Errors of Refraction and Anomalies of Accommodation; (5) Disorders of Motility of the Eye; (6) Symptomatic Diseases of the Eye; (7) Diseases of the Adnexa of the Eye; (8) Hygiene of the Eye.

The second, fourth and fifth sections, dealing as they do with ocular refraction and the convergence-accommodative problem are naturally the sections which would be of chief interest to the optometrist. These chapters are written in the usual conservative medical style, emphasis being placed on the use of a mydriatic. However, the several hundred pages dealing with this phase of ocular work are well written and

contain much good orthodox "optometry" which should not be overlooked in one's zest over some new or sensational theory. It must be remembered that the profession of optometry was erected on these same orthodox principles which the medical men have now borrowed and that these principles have, in the main worked well for the last fifty years. Sir John Herbert Parsons has again done a nice piece of work in his revised seventh edition. C. C. K.

* * * * *

CATARACT, ITS ETIOLOGY AND TREATMENT. Clyde A. Clapp, M.D., F.A.C.S., Associate Professor of Ophthalmology, Johns Hopkins University; Professor of Ophthalmology, University of Maryland; Visiting Ophthalmologist, Johns Hopkins Hospital and Wilmer Institute; Ophthalmologist, University of Maryland Hospital. Published by Lea & Febiger, Philadelphia, Pa. 254 pages, 92 illustrations. $4.00. 1934.

Clapp's new book on cataract is as complete a work on this subject as could be wished for. It is a comprehensive treatise on the normal crystalline lens and its pathological changes. The book contains much valuable material on the embryology, comparative anatomy, physiology, chemistry of the lens and other related topics, as well as a thorough study of every phase of pathology to which the lens falls heir.

In addition to this, the work deals largely with the surgical relief measures which may be relied upon to correct this type of ocular pathology. A small chapter deals with the non-operative treatment of cataract. In this chapter one misses a reference which could have been made of the work done by Hotaling and Ryer of New York City in the field of cataract prophylaxis with their red-free absorption glass therapy. This, however, is but a minor omission and by no means affects the general excellence of the work.

The book is divided into twenty-five chapters, each followed by a complete bibliography. Clapp's style of writing is clear and the reader feels he has a complete command of his subject. This is an ocular treatise which should prove very welcome. C. C. K.

* * * * *

STRABISMUS. Henry Rich Higley, Opt.D. Second Edition. Published by the author at Pittsfield, Mass. 193 pages, 80 illustrations. $6.50. 1934.

In 1923 Higley published the first edition of this work under the title *Cross Eyes*. The first edition was, for years, one of the outstanding optometric books on the subject of orthoptic treatment. Since this time the author has spent much time treating cases and studying the problems

involved in the correction of squint. This second edition, being much more complete than the first, naturally reflects the added experience gained by Higley during the past decade.

Higley, in this new work, suggests that strabismus is caused by an unfavorable external mental influence which results in a defective fusion sense. He sets this up as an important factor in the etiology of the defect and in this he may be in a measure correct, but we cannot help but feel that this is only one of the many equally important causes of strabismus and by no means the most important. Whether or not Higley is correct in this stand, his presentation of this theory will do much to stimulate thought on this phase of the work and therefore the chapter dealing with it is most welcome.

The author also presents optometry with a new depth perception device. This is known as the Higley Depthoscope, which should prove of value not only making a diagnosis in a case of squint but also in other cases as well. This instrument, according to Higley, can be used not only to determine the presence or absence of depth perception but also to develop it where it has been found to be subnormal. An appendix, written by Dr. W. W. Stifler, of Amherst College, deals chiefly with the technical and mathematical phases of the Depthoscope.

The book is very nicely written, the author being conservative in his views and statements. He recommends most of the accepted treatment technics, all of which he reviews in great detail. The author is not, however, much impressed with any of the rotating "pin-wheel" treatment devices so much in evidence several years ago. These he believes to be of little or no value. The book, as a handbook for the optometric practitioner, is very well put together and will serve as a valuable guide in the important work of orthoptic treatment. C. C. K.

A COMPLETE INDEX OF VOLUME 11
1934

A

abduction.....7, 9, 12, 125, 175, 176, 177, 178, 243, 368, 374, 413, 416, 418, 448, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472
Abney 339, 344, 345
absolute convergence (also see convergence) 368
absorption lenses.....120, 136, 137, 138, 139, 272, 273, 274
Absorption lenses, suggestions for prescribing, J. O. Baxter, Jr..... 136
accidential squint (also see squint)..... 284
accidents due to improper illumination... 156
accommodation....2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 33, 34, 35, 66, 67, 68, 69, 118, 136, 137, 138, 190, 228, 246, 248, 249, 268, 276, 278, 286, 291, 320, 323, 326, 327, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 392, 393, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460
Accommodation, Astigmatic, B. M. Lazich. 379
Accommodation Convergence relationship, A case relating to the study of, Lloyd K. Wyatt 32
Accommodative-convergence, Philip Pollack 66
accommodative exophoria (also see exophoria) 414
actinic lens 137, 139
Adachi 55, 56
Adams, John 475
adaption, law of..... 269
adduction (also see convergence).....5, 6, 7, 123, 125, 175, 176, 177, 178, 243, 368, 374, 413, 416, 448, 462
Adler 292, 311, 344, 345, 392
Adrian 214
aetiology of disease, ocular..... 277
albino 136, 139
albuminuric retinitis 191
Alexander, G. F.....69, 278, 279, 433
algebra 74
Alger, E. M.....249, 271
Allen 345
Allen, H. S..... 108
alternating squint (also see squint)..286, 304
amblyopia (also see orthoptic treatment) 201, 205, 218, 221, 222, 224, 225, 226, 284, 286, 290, 291, 296, 297, 298, 299, 300, 301, 302, 303, 304, 310, 311, 312, 313, 348, 393, 453, 458
amblyopia ex anopsia (see amblyopia)
Amblyopic treatment technics, H. E. Pine. 221
amblyoscope (also see orthoptic treatments) 287, 288, 289, 297, 305
amblyoscopic treatments (see orthoptic treatment)
American Academy of Optometry.....1, 27, 28, 32, 48, 70, 79, 158, 185, 199, 200, 212, 214, 221, 227, 237, 248, 286, 322, 348, 390, 406, 445, 462
American Medical Association.....195, 314
American Ophthalmological Congess..... 250
American Optical Company.....225, 464
American Optometric Association....237, 314, 403, 445
Ames.....343, 344, 391, 392, 393
Amherst College 478
Analysis of the findings from a routine examination, Robert N. Walker..... 1
anatomical views 78
anatomy.....75, 78, 140, 244
Anderson, E. A..... 154
Andreae, J. Fred..... 279
anemia 37
anemia of the retina.....191, 238
angle gamma 285
Animated Fusion Training Charts, Dvorine 77, 78
aniseikonia.....390, 393, 394, 395, 396, 397, 398, 399, 400
anisometropia.....310, 396, 453, 459
antrums 404
aphakia.....69, 73, 323, 342
aphakic eyes, color tests in..... 339
aqueous.....1, 107, 190, 191, 380
Argyll, Robertson pupil..... 434
Aristotle 157
Arneson 301, 302
Aronsfeld, G. H.....316, 317
Aronsfeld Variable Prism Technic of Static Skiametry, C. C. Koch..... 316
Art of Optometry, The, E. LeRoy Ryer and Elmer E. Hotaling..... 28
arteries (also see blood vessels).....2, 52, 54, 56, 141, 276
arteriosclerosis 191, 277
asthenopia.....137, 272, 364, 369, 370
Astigmatic Accommodation, B. M. Lazich. 379
astigmatic chart 6, 250
astigmatism...23, 24, 33, 73, 74, 111, 118, 179, 203 204, 205, 206, 207, 211, 248, 260, 261, 262, 263, 264, 265, 267, 268, 280, 290, 291, 296, 379, 380, 381, 382, 383, 396, 400, 409, 449
Astigmia, a case of large amount, J. T. Rushmer 111
astigmometer 28
Atherton, C. A..... 154
Atkinson, D. T..... 321
Atkinson, T. G.....321, 362, 421, 460
atoms 80, 197
atropine (also see cycloplegic)..... 298
Atwater, D. W..... 154
auto-condensation 70
auto-condensation pad 71
autonomic nervous system..... 189

B

Baer, B. 346, 347
Baker 344
Baker, R. C. 65
Ball, J. M. 249, 270
Baly 92
Barger 92
Barr, D. P. 131, 132, 135
Bateman, Frank E. 232, 234, 235
Bates 344, 345
Bausch and Lomb Company 44
Baxter, J. O., Jr. 136
Baxter, J. O., Jr., Suggestions for prescribing absorption lenses 136
Baxter, J. O., Sr. 136
Beacher, L. Lester 198, 272, 274, 346
Beacher, L. Lester, Symptomatology of Glare 272
Bean 213
Beck 433
Behr, C. 474
Bell 106
Bergeim 131
Berzelius 146
Best, Robt. 403
Betts, F. L. 445
bichrome check test (see bichrome refraction) 322
bichrome refraction 279, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347
Bichrome Refraction, Ryer and Hotaling 322
bifocal mirror spectacles 354, 355
bifocals 4, 11, 12, 13, 17, 24, 120, 123, 124, 125, 128, 173, 291, 296, 460, 475, 476
Bifocals, Benjamin Franklin, the inventor of, J. I. Kurtz 475
Bilateral ptosis, a case of functional, J. I. Kurtz 227
bilateral squint (also see squint) 284
Binocular phenomena, a new objective technique for investigating, Robert H. Peckham 40
binocular vision, grades of 292
Boering, E. G. 195
Bohall, B. H. 346
Bohr 214
Boltzmann 87
Bose, J. C. 108
Bovie 92, 93
blenorrhea, acute 437
blepharitis 405
blepharospasm 405
blindness 70, 73, 191, 218, 286, 348, 430, 431, 435, 437, 438
Blindness, a case of monolateral, J. I. Kurtz 70
blood calcium tests 130
blood chemistry 174
blood pressure, abnormal 123, 125, 128, 136, 137, 138, 139, 277
blood vessels 1, 2, 14, 433
Blunt, K. 108
blur circles 329, 330, 331, 335, 337, 339
blur point 7, 8, 11, 13, 14, 343, 360, 361, 453, 471

Books Reviewed
Anatomical Views, C. Gustrine 78
Animated Fusion Training Charts, I. Dvorine 77
Applied Refraction with special reference to the Blur-Point Technique, Louis Jaques and George Crow 360
Atlas of External Diseases of the Eye, H. Neame 277
Cataract, C. A. Clapp 477
Diseases of the Eye, Fifth Edition, Sir John Herbert Parsons 363
Diseases of the Eye, Seventh Edition, Sir John Herbert Parsons 476
External Diseases of the Eye, D. T. Atkinson 321
Fundamentals of Practice and Analysis in Optometric Examination, S. K. Lesser 38
Heroic Age of Science, W. A. Heidel 157
Manual of the Diseases of the Eye for Students and General Practitioners, Charles H. May 361
Ocular Dioptrics and Lenses, G. F. Alexander 278
Oculo-Refractive Cyclopedia and Dictionary, Thomas G. Atkinson 362
Optics, W. H. A. Fincham 196
Physical Optics, Robert Wood 77
Practical Optometry, L. Lester Beacher. 198
Report of a joint discussion on Vision. Physical and Optical Societies, England 117
Report of the Transactions of the Twelfth Annual meeting of the American Academy of Optometry, Vol VIII 279
Seeing and Human Welfare, M. Luckiesh 280
Strabismus, H. R. Higley 477
Transactions of the Optical Congress, (England), 1933 76
Universe of Light, W. Bragg 197
Year Book of the New York State Optometric Association, 1934, D. K. Uttal and B. G. Rosenkranz 198
Bragg, W. 197, 198
brain 48, 49, 213, 221, 358, 393, 431, 433
Brown, W. I. 356
Brust, P. R. 370, 378
bulbophthalmus 283
Burge 104, 105, 108
Burkhart, E. 125
Butler, T. H. 269, 271

C

Calcification, metastatic, Russell E. Simpson 130
calcium metabolism 130, 131, 132, 134
calcium salts 130
calculus 74
California Optometric Research Institute. 131
calvaria 48, 49, 50
campimeter 284, 297, 307, 338
Cannon 216
Cantarow, A. 130, 131, 133, 135
carbon arc lamps 81, 82, 87, 89, 92, 99, 100, 105, 158, 159, 162, 163, 182, 183, 218, 219
Carleton 108, 393, 400
Carl Zeiss plant 72
Carpentier 289
case history (also see symptoms) 1, 30, 32, 36, 37, 38, 70, 109, 124, 161, 169, 170, 172, 173, 175, 176, 177, 178, 179, 181, 218, 222, 223, 272, 274, 282, 283, 374, 410, 413
Case History remote, C. C. Koch 36
cataract 139, 189, 191, 218, 219, 232, 233, 234, 235, 277, 284, 403, 405, 435, 477
Cataract cases, results of medical treatment, Thomas Harrison Fames 232
cephalic index 204, 207
chancre 427, 430, 431, 438
Chasson, D. M. 410
cheiroscope (also see orthoptic treatment) 225, 297, 298, 299, 303
Chicago Parental School 199, 200
Children, Refractive errors in, J. I. Kurtz. 473
chlorophyll 100, 101, 102, 103, 104
chlorosis 460
choroid 107, 141, 189, 190, 191, 214, 234, 432, 434, 436
choroiditis 37, 284, 405, 431, 432, 436, 438
Chromagraphology, Donald J. Mayer 119
chromagraphs 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 134, 219
chromatic aberration 331, 332, 340

chromoptometry (see bichrome refraction) 322
cilia 1, 143, 147
ciliary body (also see accommodation).. 34, 106, 107, 189, 190, 248, 268, 277, 364, 367, 368, 432, 434
ciliary relaxation 173, 244
ciliary tonicity (also see accommodation). 34
circle and square test 293
Clapp, C. A. 477
Clark, J. T. 108
Clason Visual Acuity Meter 6
cleft palate 201
Clewell, G. A. 154
club foot 201
cobalt blue glass 335
cobalt lamp test for astigmatism 118
colds, nasal 405
Colebrook, G. W. 76, 91
Collip 131, 133
colobomata 201
color blindness 129, 201, 205, 238, 323, 338, 339, 342, 435
color fields, charting (also see perimetry) 22, 119, 120, 121, 122, 123, 124, 126, 127, 129, 134, 149, 174, 191, 219, 241, 242, 284
color vision 47, 113, 117, 118, 140, 149, 150, 151, 201, 205, 338, 339, 357, 358, 359, 435
Color vision, a theory, Harry Lee Fording. 140
Color Vision, Theories of, C. C. Koch 357
Columbia University 73, 445
Colville, J. R. 154
comitant squint (also see squint) 284
Committee on the Costs of Medical Care... 185
complimentary color test 293, 322
complimentary colored negative image... 360
Compton, A. H. 86, 93
congenital amblyopia 291
conical cornea 73
conjunctiva 1, 131, 189, 220, 277, 431, 432, 433, 435, 436, 437
conjunctivitis....189, 191, 238, 370, 405, 435, 437
constant squint (also see squint) 284
constitutional treatment in the correction of squint 296
Contact eye-glasses, C. C. Koch 72
contact lenses 72, 73, 74, 76
convergence (also see extra-ocular muscles) 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 34, 35, 66, 67, 68, 69, 115, 116, 117, 125, 136, 137, 138, 246, 280, 283, 286, 303, 304, 323, 343, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 393, 405, 412, 413, 414, 415, 416, 417, 418, 419, 421, 422, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472
convergence, absolute and relative (see convergence) 368
Convergence-Accommodation relationship, A case leading to the study of, Lloyd K. Wyatt 32
Convergence-Accommodation, the question of, Philip Pollack 66
Convergence Ocular. Charles Sheard...412, 448
convergent squint (also see squint) 284
Copeland, J. C. 340, 344, 345
Copernicus 326
Coque, Max 215
cornea 1, 42, 44, 50, 52, 53, 55, 73, 105, 106, 111, 116, 189, 190, 193, 205, 277, 278, 280, 284, 290, 380, 430, 431, 433, 434, 435, 436, 437, 440
Corneal image test 285
corneal scars 283
Cornu 85
CorrectEYEgraphs 224, 225, 226
cosmic rays 83, 84, 85, 86, 94, 95
Cover test 285
Cowan, R. 108
Crile 215
Crisp, Wm. H. 250
Crogs, Andrew Jay 75, 307, 320, 450
cross cylinder 10, 11, 250, 413
cross cylinder test 11, 398
Crow, G. 360, 421
Cruse, L. M. 463, 465, 466
crystaline lens 105, 106, 107, 116, 189, 190, 191, 193, 232, 233, 234, 268, 277, 284, 339, 379, 381, 382, 433, 477
Curies 83
Cushing, H. C., Jr. 152, 154
cyclitis 37, 190, 238, 431, 434, 436
cyclodamic test 168
cyclophoria 396
cycloplegic (also see atropine) 118, 248, 249, 250, 252, 254, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 267, 268, 269, 270, 298, 379, 474
Cycloplegic, Refraction with and without, J. I. Kurtz 248
cylindrical lens 3, 5, 111, 346, 364, 365, 379, 380, 383

D

Dana 213, 216
Daniels 213
dark adaptation 117
d'Arsonval 214
Dartmouth College 392, 445
Davis, A. E. 269, 270, 421, 460
Davisson 93
Dearborn 311
DeBroglie 214
Decker, J. C. 271
Dempser 93
depthoscope, Higley 478
depth perception 33, 34, 42, 74, 112, 113, 117, 478
depth perception test 112, 113
Depth perception test, a simple monocular, C. C. Koch 112
dermatology 321
DeSchweinitz, G. 65, 248, 270
detachment of the retina 191
DeWecker 249
diabetes 37, 238, 276, 277
Diabetes, Ocular Manifestations of, J. I. Kurtz 276
Diagnosis and symptoms, C. C. Koch 113
diagnosis from objective refractive findings 47, 113
diagnosis of ocular pathology, need for... 438
diagnosis of squint (also see squint)...282, 294
diet 130, 131
dilator muscle of the iris 474
diplopia 5, 7, 44, 66, 69, 115, 175, 176, 223, 242, 285, 349
disections of extrinsic ocular muscles...48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65
divergent squint (also see squint) 284
Dixon 91
dizziness 121, 189, 397, 398
Doane, Howard C. 279, 390
Doane, H. C., The clinical significance of differences in the size and shape of ocular images 390
Doane, S. E. 154
Dobson, Margaret 421, 460, 461
Doland, C. K. 463, 467, 468
Dolland 475, 476
dominant eye 283, 286, 298, 307, 311
Donders 2, 15, 25, 65, 151, 365, 377, 412, 444, 455, 456
Dorowolski 379
Dove 444
Duane, A. 270, 290, 311, 421, 453, 461
Ducrey's strepto-bacillus 430, 437
Duke-Elder, W. S. 91, 108
duochrome refraction (see bichrome refraction) 322
DuPlessis, G. L. 403

Durgin, W. A. 153
Dvorine Animated Fusion Training Charts 77
Dvorine, I. 77, 78
dynamic lenticular astigmatism (also see astigmatism) 379, 380, 381, 382
dynamic skiametry (see skiametry-dynamic)

E

Eames, Thomas H. 232, 234, 235
Eames, T. H., Results of medical treatment in cataract cases 232
ear 404, 405
Eberhart, Nobel M. 245
ectropian 190
Edser 344, 345
Education and research, optometric, J. I. Kurtz 236
Education, Graduate Optometric, J. I. Kurtz 403
Education, optometric, W. H. Glazer 74
Effect of light which enters the eye, J. I. Kurtz 239
Ehrlich 424
Eidinow 91
Ekkage 435
Eldridge-Green 151
electric waves 80, 86, 93
Electro-Magnetic spectrum, Chas. Sheard. 79
Elliotson 195
Ellis 108
embolism of the retinal arteries 191, 277
emmetropia .. 202, 203, 204, 205, 211, 395, 414, 451
encephalitis 238
entropian 190
epilepsy 286
episcleritis 190
ergosterol 92
ericiscope 322
erysipelas 430
esophoria (also see extra ocular muscles) 3, 5, 6, 7, 9, 10, 12, 25, 33, 115, 136, 159, 164, 165, 174, 175, 176, 177, 178, 182, 183, 184, 205, 208, 209, 210, 211, 217, 247, 304, 374, 377, 396, 414, 415, 416, 418, 420, 459
esotropia (also see squint) 175, 223, 247
essential squint (also see squint) 284
Eusterman, G. B. 114
Examination, analysis of the findings, Robert N. Walker 1
Exogenous toxemia diagnosed by chromagraphology, Donald J. Mayer 119
exophoria (also see extra ocular muscles) 3, 5, 6, 7, 8, 9, 10, 13, 25, 68, 69, 115, 117, 125, 137, 165, 184, 205, 208, 209, 224, 286, 304, 367, 374, 375, 396, 398, 399, 414, 415, 416, 417, 418, 419, 420, 451, 458, 459, 460, 470
exophthalmic goitre 273
exophthalmos 435
exotropia (also see squint) 32, 33, 34, 114, 115, 116, 117, 224, 247, 286
Exotropia, a case of, N. Levin 114
external examination 1, 109, 134, 193, 277, 282, 398
extra-ocular muscles (also see convergence and orthoptic treatment) 9, 27, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 113, 114, 115, 116, 117, 118, 123, 124, 128, 134, 136, 179, 205, 208, 222, 223, 238, 240, 241, 244, 245, 246, 247, 280, 365, 368, 372, 376, 393, 398, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 431, 433, 448, 449, 450, 451, 452, 453, 454, 455, **456, 457, 458, 459, 460, 462, 463,** 464, 465, 466, 467, 468, 469, 470, 471, 472, 477, 478
Extra Ocular Muscles, Mechanical Experiments to reproduce the functions of F. McFadden 244
Extrinsic muscles of the eye, R. M. Hall ... 48
eye and hand, co-ordinated movements 298, 299
eyeball 27
eyelashes 432
Eye Tic, a case of, H. Leslie Salov 109

F

F and L test 33, 34, 115
false squint (also see squint) 284
Fatigue, Visual caused by Glare, C. C. Koch 359
Feinbloom, Wm. 72, 73, 279, 288, 311, 313, 362, 404
Fernandez, Santos 431
Fernberger 110
Ferree 118
fifth nerve, nasal branch 52, 404, 430
filters, colored 328, 329, 334, 335, 336, 337, 339, 340, 341, 343, 346
Fincham, W. H. A. 196, 197
fixation for skiametry 290, 291
focal infection (also see toxemia) 7, 8, 13, 14, 119, 121, 123, 124, 128, 129, 174, 189, 190, 201, 205, 211, 404, 405, 460
foot-candle meter 154
forceps, dissecting 48, 49
Fording, Harry Lee. ... 140, 141, 142, 144, 146, 150
Fording Harry Lee, A theory of color vision 140
Foster 99, 101, 108
Fournier 431, 435
fourth nerve 277
fovea 149
Franklin, Benjamin 475, 476
Franklin Institute 197
Frederick 475
Fuchs 52, 55, 56, 65, 249, 271
functional blindness 71
fundus (also see retina) 2, 234, 339
fungus 430
fusion (also see accommodation and convergence) 286, 292, 293, 306, 415, 419
fusion training (see orthoptic treatment)

G

Galen (Claudius Galenus) 424
gamma rays 81, 83, 84, 85, 86, 93, 94, 95
Gasson, W. 423
Gasson, W., Ocular Involvements from Venereal Diseases 423
Gates 91
Gaucher 435
genetics 75, 278
Genothalmic color lantern 339
geometric optics 29, 197, 212, 278
geometry 74, 278
Giessing, H. G. A. 237, 238
glare 272, 273, 274, 359, 360, 403
Glare, Symptomatology of, L. Lester Beacher 272
glare test, subjective 273, 274
Glare, Visual Fatigue caused by, C. C. Koch 359
glarometer 274
glass, transmission of 81, 97, 98, 99, 100, 101, 102, 103, 322
glaucoma 37, 189, 190, 191, 193, 238, 249, 403, 405
Glaucoma, H. Leslie Salov 193
Glazer, W. H. 76, 403
Glazer, W. H., The fundamentals of Optometric education 74
Gliddon, G. 343, 391, 392, 393
Gobar, F. H. 370, 378
gonococcus 429, 437, 439
gonorrhea 37, 425, 426, 427, 429, 436, 437, 438, 440
Gonzalees 213

Gould, George M. 155
Graduate Foundation Clinic 3, 6, 7, 9, 11, 13, 14, 15, 27, 38, 39
Grant 91
grating, fine line 333
Gray, W. H. 276, 277
Green, W. 76
green-blue filters 328, 329, 334, 335, 336, 337, 340, 341, 342, 347
Greenwald 133
Greiner 93
Griffith 88, 92
Gross 133
Grotthus 91
Gudden 435
Guibor, G. P. 318, 319
Gullstrand 381
gummata 427, 434, 438
Gustrine, Chas. 78

H

Haitz charts 284
Hall, R. M. 48, 55, 56, 279, 281, 312, 313, 318, 346, 362
Hall, R. M., A study of the extrinsic muscles of the eye 48
Hall, R. M., The Non-operative treatment of Strabismus 281
hand and eye, co-ordinated movements 298, 299
handedness, its relation to eyedness..44, 47, 201, 279, 283, 298, 299
Hansell 56, 249, 270
Hardy, W. E. 76
Harman 435
Harmon, M. M. 346
Harrington, R. E. 154
Harrison, W. 154
Hart 91, 97
Harthausen 91
Hartridge 106
Harvey 326
Hastings 344, 345
headaches (also see symptoms) 70, 120, 121, 165, 169, 170, 172, 177, 178, 180, 189, 219, 220, 275, 276, 397, 398, 405, 458
heart, involvements of 37, 276
Heather, W. J. 199, 345
Heather, W. J., and Needles, W. B., Optometric Survey 199
Heidel, William A. 157
Heine, L. 73
Helmholtz 65, 75, 150, 151, 278, 312, 322, 344, 345, 357, 359, 412
Hemianopsia spectacles 348, 349, 350, 351, 352, 353, 354, 355, 356
hemorrhages of the retina (also see retina) 191, 277, 284, 405, 432, 433
Henry 290, 298
Hensen 380
heredito-syphilis (also see syphilis)..428, 435
heredity 212, 213, 282, 311
Hering, Ewald 151, 357, 358, 359
herpes 430
herpes corneae 430
herpes febrilis 430
herpes ophthalmicus 430
Herschel 84
Hertel 92
Hertz 80, 82, 84
Hertzian waves 82, 84, 85, 86, 94, 95
Hess 91, 92
heteronymous hemianopsia 349
heterophorias 208, 211, 223
Hibben, S. G. 154
Higgins 89, 91, 97, 98, 99, 100, 101, 108
high-frequency 71
Higley, H. R. 321, 477, 478
Hill, Leonard 91, 92, 106, 108
Hirschenberg 289
History, Case. C. C. Koch 36
Hofmeister, F. 132, 135
Holweck 85
homonymous hemianopsia 279, 348, 349 350, 351, 352, 353, 354, 355
Homonymous Hemianopsia, The Optical Correction of a case of Charles E. Jaeckle 348
horoptor 391, 392
Horton, Hammond S. 240
Horton, Hammond S. Mid-Life Imballance Phenomenon 240
Hotaling, Elmer E. ..28, 279, 322, 345, 346, 404
Hotaling, E. E. and Ryer E. LeRoy. Bichrome Refraction 322
Hotaling, Elmer E. and Ryer, E. LeRoy. The Art of Optometry 28
Houstoun 345
Howe, Lucien 55, 65, 365, 377, 448
Humphris, F. H. 108
Hutchinson teeth 284, 428, 436
Huxley 75
Huygens 197
hyaloid artery 233
hypercalcemia 132
hyperemia of the optic nerve 192
hyperemia of the retina 191
hyperopia 3, 4, 5, 12, 24, 118, 159, 165, 168, 169, 170, 171, 172, 173, 174, 177, 178, 179, 180, 181, 182, 183, 203, 204, 205, 206, 207, 208, 209, 210, 211, 249, 268, 269, 275, 276, 285, 286, 311, 323, 326, 342, 372, 396, 417, 421, 449, 450, 453, 458, 473, 474
Hyperopia, Ocular symptoms in, C. C. Koch 275
Hyperparathyroidism. Russell E. Simpson 130
hyperphoria 6, 9, 67, 125, 128, 205, 377, 396
hysteria 71

I

Igersheimer 355
Illuminating Engineering Society 446
illumination 152, 153, 154, 155, 156, 157, 273, 280, 401, 402, 446, 447
Illumination, hygiene of. Kurtz, J. I..401, 446
Illumination requirements table, minimum 154, 155, 401, 402, 447
Imbert 322, 340, 342
inferior orbital canal 49
influenza 238, 405, 430
infra-red radiations 79, 81, 84, 85, 86, 89, 93, 94, 95, 100, 102, 103, 104, 106, 107
Ingalls, A. G. 90
inner canthus 48
insanity 286
insomnia 120
Insurance, Compulsory Health. C. C. Koch 314
interferometers 86
interpupillary gauge 28
interstitial keratitis 425
intestinal auto-intoxication 131, 135
intestine 131
intraocular tension 50
ionization chambers 90
iris (also see pupil) 1, 42, 47, 106, 107, 137, 189, 190, 277, 351, 432, 434, 474
iris, reaction of 474, 475
Iris, the muscles of, and their action. Kurtz, J. I. 474
iritis 37, 189, 190, 191, 248, 405, 427, 431, 432, 436, 437, 438, 440
iseikonia 393
iseikonic lenses 393, 399, 400
Ishihara color test 339
itch 430
ivory ball visual acuity test 290

J

Jackson, Edward 249
Jaeckle, Charles E.....279, 348, 356
Jaeckle, Charles E. Optical Correction of a case of Homonymous Hemianopsia... 348
Jaensch 312
Jagolinzer, C. 36
James, William 75
Jaques, L.....360, 362, 421, 461
Javal 289, 412
Jeans 83, 95
Jennings 345
Jenson, Geo. C..... 403
Johnson 102
Jones, Ray V.....70, 71

K

Karpinska 444
Kempf 213
keratitis.....37, 189, 190, 283, 405, 425, 430, 434, 435, 438, 439
keratoconus 73
kidneys 131, 132
Kight, A. C.....463, 465, 466
Klotz, O.....131, 135
Knapp 412
Knowlton 214
Koch, C. C.....38, 39, 74, 77, 78, 113, 114, 157, 158, 159, 160, 161, 168, 183, 184, 198, 230, 276, 278, 279, 280, 316, 317, 319, 321, 359, 360, 361, 362, 363, 403, 404, 421, 461, 477, 478
Koch, C. C. Case History, remote..... 36
Koch, C. C. Compulsory Health Insurance 314
Koch, C. C. Contact eye-glasses..... 72
Koch, C. C. Depth perception test..... 112
Koch, C. C. Diagnosis and Symptoms.... 113
Koch, C. C. Lighting and vision..... 152
Koch, C. C. Ocular Symptoms in cases of Hyperopia 275
Koch, C. C. Optometric Classics..... 319
Koch, C. C. Orthoptic Treatment work in Squint Cases 317
Koch, C. C. Theories of Color Vision..... 357
Koch, C. C. Use of visible light in the correction of refractive and muscular abnormalities 158
Koch, C. C. Visual Fatigue caused by glare 359
Koch-Weeks bacillus 426
Kohlhoester 83, 85
Kraskin, Lewis H..... 279
kratoculator (also see orthoptic treatment) 303
kratometer (also see orthoptic treatment)....28, 223, 245, 297, 307, 463, 464, 465
Krilenyi 475
Krolls 297
Kuntz 216
Kurlander, J. H..... 154
Kurtz, J. I.....70, 78, 118, 157, 160, 166, 195, 196, 197, 198, 215, 227, 239, 248, 277, 280, 402, 403, 404, 444, 445, 447, 474, 475, 476
Kurtz, J. I. Benjamin Franklin the inventor of Bifocals..... 475
Kurtz, J. I. Bilateral ptosis, a case of.... 227
Kurtz, J. I. Effect of light which enters the eye 239
Kurtz, J. I. Graduate Optometric Education 403
Kurtz, J. I. Hygiene of Illumination..401, 446
Kurtz, J. I. Monolateral blindness treated with physical agents, a case of..... 70
Kurtz, J. I. Muscles of the Iris and their action 474
Kurtz, J. I. Ocular Manifestations of Diabetes 276
Kurtz, J. I. Ocular symptoms in general pathology 237
Kurtz, J. I. Optometric Education and research 236
Kurtz, J. I. Optometry's advancement.... 194
Kurtz, J. I. Pupillary size as a measurement of ocular fatigue..... 196
Kurtz, J. I. Refraction with and without a cycioplegic 248
Kurtz, J. I. Refractive errors in children. 473
Kurtz, J. I. Research Foundation of the Pennsylvania State Col. of Optometry.. 444
Kurtz, J. I. Stereoscopic vision..... 441
Kurtz, J. I. Symptoms of Ear and Throat involvements 404

L

lacrymal bone 56
lacrymal duct 48
lacrymal gland 52, 277, 433, 437
Ladd-Franklin, Christine 151, 357, 359
lamina cribosa 50
Landachre, F. L..... 65
Landolt, E.....365, 368, 376, 377, 412, 454
Langley 84
Lasley 216
Latham, J. R..... 136
Laurance, L.....288, 312, 320, 328, 344, 345
Laurens 86
Lazich, B. M..... 379
Lazich, B. M., Astigmatic Accommodation 379
ienticular astigmatism.....379, 380, 381, 382
Lesser, S. K.....38, 39, 460
Leutz, C. R..... 108
levator palpebrarum muscle..... 228
Leventhal, J. H..... 246
Levin, N. 117
Levin, N., A case of exotropia..... 114
Lewis, L. I..... 360
lice 430
lids, eye.....1, 49, 105, 134, 227, 228, 229, 230, 231, 232, 273, 276, 277, 406, 407, 409, 410, 431, 432, 433, 435, 437
Liebnitz 475
light stimulation in the treatment of amblyopia (also see orthoptic treatment) 298
Lighting and vision. C. C. Koch..... 152
lighting, proper....29, 152, 153, 154, 155, 156, 157, 280, 359, 401, 446, 447
Lighting Research Laboratory..... 446
Lloyd 312
Lockwood 344, 345
locomotor ataxia 427
Lodge 84
Loeb, Carl 158, 159, 160
London Lock Hospital.....438, 439
London Optical Association..... 404
London Refraction Hospital.....423, 438
longitudinal horoptor 391
Luck, J. M..... 108
Luckiesh, M.....108, 154, 156, 196, 280, 446
Lueck, I. B.....340, 344, 345
lues cerebri 238
Lyman 85
lymph 145
Lyon, E. P..... 403

M

Macfie, R. C..... 239
macula 214
maculovator (also see orthoptic treatment) 298, 303
maddox double prism..... 368
Maddox, E. E.....65, 225, 289, 298, 312, 365, 377, 412
maddox rod 67, 368
Madigan 393, 400
MacElree, George A..... 280
Magdsick, H. H..... 154

manuductor (also see orthoptic treatment) 297, 298, 303
Marton, H. B. 77
massage 71
Mathews, A. P. 108
maxilla 55
Maxwell 79, 80
May, Charles H. 361
Mayer, D. J. 119, 122, 126, 127, 129
Mayer, Donald J., The effects of exogenous toxemia diagnosed by chromagraphology 119
Mayer, E. 108
Mayo Clinic and Foundation. 364, 403, 412, 448
McCordock, Howard 132
McCulloch, O. 312
McDougall 151
McFadden, F. 213, 244, 246, 384
McFadden, F., A Five outlet rheostadt. .. 384
McFadden, F., Mechanical Experiments to reproduce the functions of the Extra-Ocular Muscles 244
McIlroy, H. 473
Medical treatment in cataract cases. T. H. Eames 232
megaleikonia 393
Melvin, O. J. 216, 279
meningitis 405, 434
menopause 286
mercury compounds 423, 424
metabolism test 174
Metastatic Calcification-Hyperparathyroidism. Russell E. Simpson 130
metronome, Maezel 464
micreikonic 393
Mid-Life Imbalance Phenomenon. H. S. Horton 240
migraine 397
Miles 345
Miller, Eugene 151
Millikan, R. A. 83, 85, 86, 108
Minnesota Academy of Optometry. 403, 444, 446
mirror spectacles 352, 353, 354, 355
Moeli 435
Mohr 433
monochromatic light 334, 335
monochromators 90
Monolateral Blindness, a case of. J. I. Kurtz 70
Morgan, J. J. B. 231
Morris 216
Morrow, John F. 280, 313
Mortenson, Peter A. 200
Morton, A. S. 268, 270
Moss, Frank K. 154, 156, 196, 446
motor nerves 404
Muscles, extrinsic. R. M. Hall 48
mydriasis of the iris 190
Myer 270
myoculator (also see orthoptic treatment) 289, 297, 301, 302
myologic imbalance 240, 281
myologic unit (also see orthoptic treatment) 223, 225, 289, 297, 301, 302
myopia 3, 24, 29, 34, 67, 73, 77, 118, 137, 161, 165, 183, 203, 204, 205, 206, 207, 208, 209, 210, 211, 220, 273, 285, 286, 342, 343, 372, 396, 403, 417, 435, 449, 450, 452, 453, 473, 474
myosis of the iris 190

N

nascentizing 218, 219, 220
Nathanson 110
National Academy of Science 441
Neale, A. R. 463, 467, 468
Neame, H. 277, 278
Needles, W. B. 199, 422, 461
Needles, W. B. and Heather, W. J., Optometric Survey 199
negative fusion reserves (also see abduction) 416, 418, 458, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472
Negative Fusional Convergence Amplitude, an investigation of the. Wm. J. Tait 462
negative image 360
Neill, John C. 279, 406
Neill, J. C., Ptosis Crutches 406
Neisser 429
nephritis 131, 132
Nernst 87
nerve head 2
Neumann 433
Neumueller, J. 347, 393, 404
neurology 78, 240
neuropathic divergent strabismus (also see squint) 286
neuropathic squints (also see squint) 286
neuroretinitis 191, 405
Newman 75
Newton, Sir I. 81, 84, 197, 322, 338, 344, 475
New York Post Graduate Medical School. 249
Nichols 84, 86
night-blindness 114
normalizing unit, Wottring (also see orthoptic treatment) 297, 301, 302, 303, 307, 308
Northampton Politechnic Institute of London 197
Northern Illinois College of Optometry .. 199, 200, 211
nose 404, 405
Nott, I. S. 422, 461
nystagmus 32, 201, 238, 295, 310, 405, 434

O

Oblath 345
occasional squint (also see squint) 284
occlusion, the use of (also see orthoptic treatment 298
Ocular Convergence, Charles Sheard 412
Ocular Disease, the recognition of. D. R. Paine 185
ocular fatigue engendered by glare 153, 154, 272
Ocular fatigue, pupillary size as a measurement of. J. I. Kurtz 196
ocular hygiene 29, 128, 129
Ocular Images, the clinical significance of differences in the size and shape of. Howard C. Doane 390
ocular images, the size and shape of .. 279, 390, 391, 392, 393, 394, 395, 396, 397, 399, 400
Ocular palsies 277
Ocular symptoms in general pathology. J. I. Kurtz 237
Ocular symptoms of Ear and Throat involvement. J. I. Kurtz 404
Oday, A. B. 154
Oertel, G. D. 312, 346
Ogle 391, 392, 393
Ohio State University 65
opaque disc 33
ophthalmia neonatorum 430, 436, 439
Ophthalmic Hospital of London 439
ophthalmo-eikonometer 394, 395, 396, 397, 398, 399, 400
Ophthalmological Society of the United Kingdom 269
ophthalmometer 3, 5, 28, 33, 128, 222, 223, 248, 269, 290, 324, 362, 398, 413
ophthalmoscope 2, 22, 28, 33, 109, 120, 123, 174, 191, 192, 220, 222, 223, 228, 234, 249, 269, 273, 283, 284, 285, 289, 384, 389, 398, 413, 433
optic atrophy 189, 192, 232, 434, 435, 438
optic foramen 48, 49, 51, 52, 148
optic nerve 50, 51, 52, 55, 141, 148, 189, 191, 192, 232, 234, 239, 241, 433, 434, 435, 437

optic neuritis 433
optic tracts 148
optics, theoretic 74
Optical control of the central gray. H. Riley Spitler..... 212
optometer-stereo, Wells (also see orthoptic treatment).....293, 297, 317
Optometric Classics. Koch, C. C..... 319
Optometric education and research. J. I. Kurtz..... 236
Optometric Education, Graduate. J. I. Kurtz..... 403
Optometric education, the fundamentals of. W. H. Glazer..... 74
Optometric Quantitative Analysis of the findings from a routine Examination. Robert N. Walker..... 1
Optometric survey at the Chicago Parental School. W. B. Needles and W. J. Heather 199
Optometry, the Art of. E. LeRoy Ryer and Elmer E. Hotaling..... 28
Optometry's advancement. J. I. Kurtz.... 194
orbiculars oculii 48, 49, 52
orbital contents 48, 49, 50
orbital contents, the removal of.....48, 49
orbits.....35, 48, 275, 283, 404, 405, 431
orthophoria.....3, 5, 6, 7, 9, 25, 205, 208, 209, 211, 223, 396, 414, 420
orthoptic treatment.....3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 18, 22, 23, 24, 32, 34, 115, 116, 117, 124, 128, 162, 175, 176, 177, 178, 182, 240, 242, 243, 247, 286, 287, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 317, 319, 321, 377, 412, 417, 419, 458, 460, 462, 477, 478
Orthoptic treatment room.....296, 297
Orthoptic treatment work, the value of in squint cases. Koch, C. C..... 317
otoscope..... 384

P

Pacini, A. J..... 108
Paine, D. R..... 185
Paine, D. R., Optometry's obligation in the recognition of ocular disease..... 185
palilladeoma 405
Palladin, V. I..... 108
palpebral fissure 283, 407, 409
palsy, bilateral 238
paralytic squint (also see squint)..... 284
parathyroid glands.....91, 96, 97, 98, 99, 100, 107, 131, 133
Parsons, Sir J. H.....363, 476, 477
Pascal, J. I.....268, 271, 422, 450, 461
Pasque 214, 215
Pasteur 326
Pathology, ocular symptoms in general. J. I. Kurtz..... 237
Pavlov 67
Pech 322, 336, 340, 342
Peckham, Robert H..... 40
Peckham, Robert H., A new precision stereoscope and a new objective technique for investigating binocular phenomena 40
Peckham, R. M.....12, 213, 221, 223, 224, 298, 312, 422, 461
pediculosis 430
Peneke 133
Pennsylvania State College of Optometry.....75, 76, 236, 237, 444, 445, 462
perception, testing for simultaneous.292, 307
Percival, A. S.....238, 364, 365, 368, 369, 370, 371, 372, 374, 375, 376, 377
perimeter.....28, 119, 129, 191, 193, 219, 283, 284, 297, 338, 351, 405
periodic squint (also see squint).....284, 286
periosta.....48, 49, 52, 54, 55
Peter, L. C.....319, 422, 461
Petry, Ernest 278
pharynx 405
Phi Sigma Epsilon, Beta Chapter..... 119
phoria tests.....3, 5, 9, 10, 11, 14, 47, 66, 67, 69, 109, 115, 134, 168, 175, 176, 177, 178, 208, 209, 210, 369, 398, 413, 459
phorometer (also see orthoptic treatment).....69, 380, 454, 464
photochemical activation 87, 88
photo-electric cell 328
photometer, Bunsen grease-spot..... 328
photometer, Flicker 328
photometer, Lummer-Brodhum 328
photometer, Rumford shadow..... 328
photometry 328
photophobia 70, 125, 133, 136, 137, 138, 139, 201, 272, 273, 276, 397, 405
physical examinations.....174, 175, 242, 294
physical therapy, ocular.....70, 71, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 195, 228, 229, 230, 231, 232
physician, family—referring patients to.....174, 175, 242, 294
physics of light.....74, 75, 77, 197, 358
physiological cup 2, 190
physiological exophoria (also see exophoria).....9, 125, 136, 367, 415, 471
physiological optics.....74, 382
physiology 75
Piccard 86
Pickard, R. 112, 113
Pierce, G. J..... 108
Pierce, W. I..... 404
Pincussen 91
Pine, Harry E.....221, 297, 312
Pine, H. E., Amblyopic treatment technics 221
Planck 80, 92
Plato 157
pneumococcus 426
pneumonia 430
Pollack, P. 66
Pollack, Phillip. The question of accommodation-convergence 66
polygraph 44
polychromatic light 334
polyopia 349
positive fusional convergence reserve (also see adduction).....416, 458, 462
Powell, A. L..... 154
Prentice, Charles F.....320, 414, 415
Prentice rule 414, 415
presbyopia.....12, 24, 240, 327, 342, 369, 414, 418, 450, 452, 453, 457
preserving fluids, dissecting ocular..... 49
Preston 344, 345
Priestley-Smith 289
primary colors 358
prism, spectra obtained from..... 333
prismatic corrections, the prescribing of (also see orthoptic treatment).....364, 374
Prisms, the prescription of. Chas. Sheard. 364
prisms, the use of adverse.....296, 302
Proctor 344
prognosis from refractive findings.47, 227, 233
projection, the establishment of true..... 303
prophylaxis 29
pseudo-myopia (also see myopia)....159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 182, 183, 323, 343, 417
pseudoscope, Stratton type.....44, 46
pseudo-squint (also see squint)..... 284
psychic squint (also see squint)..... 281
psychoanalyst 282
psychology....75, 157, 164, 166, 178, 239, 270, 280, 287, 295, 441
Psychology of stereoscopic vision. J. I. Kurtz..... 441
Ptosis crutches, a further report on. J. C. Neill..... 406

ptosis, functional bilateral.....227, 228, 229, 230, 231, 279, 283, 405, 406, 407, 408, 409, 410, 411
Ptosis, functional bilateral, a case of. J. I. Kurtz..... 227
ptosis spectacles....321, 406, 407, 408, 409, 410, 411
pulse rate 174
punctae 1
pupil (also see iris)....1, 21, 32, 107, 137, 138, 141, 190, 191, 196, 220, 222, 228, 238, 248, 249, 273, 351, 407, 410, 432, 434, 436
pupillary distance.....44, 67, 116, 117, 414
pupillary reflex tests.....273, 398
Pupillary size as a measure of ocular fatigue. J. I. Kurtz..... 196
pyorrhea 123, 124

Q

quartz spectroscopes..... 90
quiniodin 91

R

radiant energy.....79, 91, 92, 93, 96, 99, 100, 101, 103, 104, 105, 106, 107, 160, 161, 163, 166, 168, 173, 177, 179, 182, 193, 214, 215, 222, 333, 334, 336
radiometers 86
Rand 118
Rea, R. L..... 438
Reber 56
red filters 298, 328, 329, 334, 335, 336, 337, 340, 341, 342, 347
red-free glass, the use of..... 279
Refraction with and without a Cycloplegic. J. I. Kurtz..... 248
Refractive errors in children. J. I. Kurtz. 473
refractor 28
relative convergence (also see convergence) 368
Research and optometric education. J. I. Kurtz..... 236
Research Foundation of the Pennsylvania State College of Optometry. J. I. Kurtz. 444
retina (see fundus)....69, 106, 113, 118, 120, 121, 122, 134, 137, 141, 142, 143, 145, 148, 151, 189, 191, 193, 213, 214, 219, 234, 238, 239, 277, 284, 325, 334, 335, 339, 351, 352, 354, 358, 359, 382, 390, 391, 392, 393, 394, 405, 431, 432, 433, 436, 437, 442, 443, 452
retina, microscopic examination of..... 145
retinal fatigue 360
retinal synapse 118
retinitis.....277, 405, 431, 432, 433, 437, 438
retinitis pigmentosa 433
retinoscope (see skiametry).....28, 285, 291, 316, 317, 324, 379, 384, 389, 398, 413
retinoscopy (see static skiametry and dynamic skiametry)
retrobulbar neuritis 238, 405
Rhazes 425
Rheostadt, a five outlet. F. McFadden.... 384
rheostat, ophthalmic.384, 385, 386, 387, 388, 389
rheumatism 37
rickets 130, 131
Righi 84
Riley 241
ringworm 430
Ritter 81, 85
Robinson 91
Robinson, S. H.....321, 422, 461
Roentgen.....82, 83, 85
Rood 344, 345
Rosenheim 92
Rosenkranz, B. G..... 198
rotary prism (see phorometer)..3, 6, 69, 293, 297, 317
Rothman 92
Rubens 84
Rushmer, J. T..... 111
Rushmer, J. T., a case of large amount of astigmia 111
Russell 214
Russell, E. H..... 108
Russell, W. K..... 108
Rutherford 83, 85
Ryer, E. LeRoy....28, 279, 280, 320, 322, 345, 346, 347, 362, 404
Ryer, E. L. and Hotaling, E. E., Bichrome Refraction 322
Ryer, E. LeRoy and Hotaling, Elmer E. The Art of Optometry..... 28

S

Salov, H. Leslie.....109, 103
Salov, H. Leslie. A case of eye tic..... 109
Salov, H. Leslie. A case of subnormal vision-glaucoma 193
salvarsan 423, 424
Savage, G. C.....312, 365, 377
scabies 430
scalpel 48, 49
Schanz..... 345
schematic eyes 29
Schneller 52
Schultze, Max 144
Schumann 85
sclera.....1, 52, 141, 189, 190, 277, 432, 434
scleritis 190
sclerosis, disseminated 238
scotoma.....238, 284, 405, 434
Screen test 285
selenium 147, 148, 151
Sheard, Charles....75, 76, 79, 89, 91, 92, 97, 98, 99, 100, 101, 102, 108, 304, 312, 320, 344, 345, 362, 364, 377, 379, 403, 404, 412, 422 448, 450, 451, 461
Sheard, Charles. Ocular Convergence.412, 448
Sheard, Charles. Some physical properties and biological effects of the radiations of the electro-magnetic spectrum..... 79
Sheard, Charles. The Prescription of Prisms 364
shingles 430
Sigaud 213
sight-meter 464
Simpson, R. E. (C. E.)..... 155
Simpson, Russell E. (Opt.D.).130, 131, 135, 403
sinus.....120, 123, 124, 205, 404, 405
sixth nerve 52, 277
Skeffington, A. M.....3, 4, 27, 38, 39, 422, 461
skiametry, fixation for.....290, 291
skiametry, dynamic (also see retinoscope) 4, 33, 38, 70, 116, 120, 137, 159, 161, 162, 163, 164, 165, 169, 170, 171, 172, 173, 174, 179, 228, 290, 320, 379, 398, 413, 450, 451, 452, 454, 457, 459, 460, 471
skiametry, static (also see retinoscope)...3, 33, 34, 70, 116, 120, 128, 137, 159, 161, 162, 163, 164, 165, 168, 169, 170, 171, 172, 173, 179, 196, 218, 222, 223, 228, 248, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 267, 268, 270, 273, 290, 316, 317, 383, 398, 413, 449, 452, 457, 458, 459, 460
slit-lamp 384
Smith, Francis M..... 134
Smith, H. A..... 154
Socrates 157
soft-sore.....430, 437, 438
Sorbonne, Paris, France..... 249
Southall, J. P. C.....73, 74, 75, 76, 344, 345
Southern Society for Philosophy and Psychology..... 40
spasm of accommodation..... 450
spectroband (also see physical therapy).160, 161, 162, 163, 164, 165, 167, 169, 173, 178, 179, 217, 218, 219, 220, 239
spectrophotometers 90, 102
spectroscope 336, 340

spectrum.....77, 79, 80, 81, 82, 83, 84, 85, 86, 88, 89, 92, 94, 95, 102, 104, 105, 158, 160, 333, 334, 335, 347, 358
Spectrum, the electro-magnetic. Charles Sheard 79
spectrum transmission charts..... 138
Sperti 214
sphincter muscles of the iris..... 474
spinal miosis 434
Spitler, H. Riley.....158, 183, 212, 214
Spitler, H. Riley. Optical control of the central gray 212
Spoehr, H. A..... 108
Spurious squint (also see squint)..... 284
squint (also see extra-ocular muscles)....33, 34, 47, 76, 77, 180, 186, 222, 223, 224, 242, 247, 279, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 313, 317, 318, 319, 435, 477, 478
Squint cases, the value of orthoptic treatment work in. Koch, C. C..... 317
squint corrector (also see orthoptic treatment).....243, 297, 301, 302
staphylococcus 426
staphyloma 190
static retinoscopy (see skiametry-static)
Static Skiametry, the Aronsfeld Prism technic of. Koch, C. C..... 316
Steenbock 91, 97
Steinmetz, C. P.....83, 108
stenopaeic slit 343
stereopsis..34, 292, 294, 308, 441, 442, 443, 444
stereoscope (also see orthoptic treatment) 40, 41, 42, 43, 44, 45, 46, 47, 224, 225, 290, 297, 307, 442, 443
Stereoscope, a new precision. Robert H. Peckham 40
stereoscope, Wheatstone (also see orthoptic treatment) 40, 46
stereoscopic treatments (see orthoptic treatment)
stereoscopic treatment charts (also see orthoptic treatment).....77, 224, 290, 294, 297, 307, 308, 442
Stereoscopic vision, the phychology of. Kurtz, J. I..... 441
stethoscope 195
stethoscopic sounds 174
Stevens, G. T.....65, 365, 378
Stickney, G. H..... 154
Stieren 435
Stiffler, W. W..... 478
Stiles, W. 108
Stilling pseudo-isochromatic color test.. 339
stimulation, direct light in the treatment of amblyopia 298
Stokes 344
strabismometer, Lawrence (also see orthoptic treatment 288
strabismometer, Maddox's tangent (also see orthoptic treatment).....289, 297
strabismus (also see squint)..... 281
Strabismus, the non-operative treatment of. R. M. Hall..... 281
St. Thomas Hospital, London..... 195
subjective tests....3, 4, 5, 8, 9, 10, 11, 15, 18, 33, 47, 118, 120, 137, 166, 169, 170, 171, 172, 173, 174, 175, 179, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 267, 268, 270, 272, 290, 322, 323, 324, 343, 346, 398, 413, 450, 457, 459
Subnormal vision, a case of. H. Leslie Salov 193
sub-normal vision, the relief of (also see amblyopia).....72, 73, 76, 193, 297
successive contrast 360
superior orbital nerve..... 51
suppression lenses (also see orthoptic treatment) 298
supra-orbital fissure 48, 49, 50
Survey, Optometric at the Chicago Parental School. W. B. Needles and W. J. Heather 199
Sutcliff, R. L..... 77
Sutler 312
Swann, L. A.....422, 461
Sweet 249, 270
symptoms (also see case history)..1, 32, 113, 114, 120, 121, 125, 128, 133, 159, 170, 175, 176, 185, 187, 188, 189, 217, 227, 237, 238, 272, 273, 274, 275, 276, 282, 283, 349, 364, 365, 394, 397, 400, 404
Symptoms and diagnosis. C. C. Koch.... 113
Symptoms in general pathology, ocular. J. I. Kurtz..... 237
synovial membrane 54
syntonized 218, 219, 220
syphilioma 427
syphilis.....37, 192, 283, 424, 425, 426, 427, 428, 429, 431, 432, 433, 434, 435, 436, 439, 460

T

tabes.....238, 427, 434, 438
Tait, Edwin Forbes.....38, 66, 137, 279, 347, 362, 404, 422, 445, 450, 461, 469, 471
Tait quantitative system of skiametry 451, 471
Tait, William J..280, 312, 462, 465, 466, 467, 468
Tait, Wm. J. Investigation of Negative Fusional Convergence Amplitude..... 462
Tanaka 132
tape, Priestly Smith's..... 289
Taylor 88, 92
Tear 84, 86
teeth.....120, 124, 205, 296
telebinocular, Keystone (also see orthoptic treatment) ..33, 225, 293, 294, 297, 307, 308
telescopic spectacles 193, 362
television 147
Telkes 214, 215
Temple University 445
tenon, capsule of.....53, 54
thermopiles 90, 103
Terrill, H. M..... 108
Tesla 84
test chart.....28, 234, 249, 270, 290, 335
Theobold, S. 268, 270
third nerve.....52, 227, 228, 277, 405
Thompson 214, 344
throat.....120, 123, 124, 404, 405
Thrombosis of the retinal vessels..... 191
Tic, eye. H. Leslie Salov..... 109
Tilney 241
Tinker, M. A.....401, 402, 403, 446
tongue 405
tonicity, nerve.....240, 241, 244, 247, 280
tonsils.....133, 205, 296
toxemia (also see focal infection)....3, 4, 8, 14, 119, 120, 121, 123, 124, 125, 127, 128, 241, 242, 404, 405
toxic amblyopia (also see amblyopia).... 192
trachoma 190
trans-illumination 120, 123, 321
transilluminator 384, 389
Traquair 238
trauma 282
traumatic squint (also see squint)..... 282
treatment of squint (also see squint and also see orthoptic treatment)..... 281
Treatment technics, amblyopic. H. E. Pine..... 221
trial case 4, 10, 249
trigonometry 74, 278
trochlear pulley 53, 54, 55
Troland, L. T.....344, 345, 359
true squint (also see squint)..... 284
Tscherning.....75, 249, 271, 344, 345
tuberculin tests 174
tuberculosis 37, 192

tumour, intra-orbital 434
Turner, A. S..... 154
Turville, A. E..... 276
Twitmyer 110

U

ulcer, corneal or conjunctival....431, 433, 436
Ulrey, C. T..... 108
ultra-violet radiations.....79, 80, 81, 83, 84, 85, 86, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 102, 103, 104, 105, 106, 107, 108, 160
unilateral squint (also see squint)..... 284
University College of London..... 195
University of California..... 445
University of Minnesota..227, 403, 444, 445, 446
University of Pennsylvania..... 445
University of Vienna..... 249
uremia 131
urinalysis.....121, 134, 174
Uttal, D. K..... 198
uveal tract....190, 191, 249, 405, 431, 432, 436
uveitis 190, 405

V

vacuum electrode 71
Valasek, J.....108, 344, 345, 403
Van Etten, N. B.....314, 315
veins (also see blood vessels)..2, 56, 141, 276, 405
Veith-Muller circle 391
Venereal Diseases, Ocular Involvements from. W. Gasson..... 423
venereal utheritis 424
Verhoeff 106
versions.....2, 222, 223, 244, 246, 247, 285
Villiger..... 216
Virchow, R.....132, 135
Visible light, the use of in the correction of refractive and muscular abnormalities. C. C. Koch..... 158
visible rays....84, 86, 93, 94, 95, 99, 100, 103, 104, 105, 108, 158, 328
visible spectroscopes 90, 328
visual acuity.....2, 5, 70, 71, 159, 161, 162, 163, 164, 165, 168, 175, 179, 180, 222, 223, 224, 290, 291, 409, 410
vitaglass 97, 101, 102
vitamin D.....98, 130
vitreous.....2, 106, 141, 190, 193, 432, 433
vitreous opacities 189
Vivian, W. O..... 280
Volkers 380
Volkman 52, 65
Voltaire 475
von Bayer 84
von Rohr 344

W

Walker, Keith 121
Walker, Robert N.....1, 27, 39, 422, 461
Walker, Robert N. A method of optometric quantitative analysis of the findings from a routine examination..... 1
Washburn, M. F.....441, 442, 444
wassermann test.....174, 428, 429
Weatherwax, J. L.....108
Webster 91, 92
Wein 83
Weinstock 91
Weiss 55, 91
Weissman 75
Weitzenhof stereoscopic attachment (also see orthoptic treatment).....307, 308
Wells 297, 312
Wells, A. A..... 108
Weston Instrument Co..... 464
Weymouth, F. W.....370, 378
Whately, George 475
Wilber, D. L..... 114
Wilkinson 288, 312
Windhaus 92
Wiseman, E. G.....275, 320
Wittlig, A. H.....48, 55, 56
Wittlig, A. H. A study of the extrinsic muscles of the eye..... 48
Wolfe, O. 403
Woll, Frederic 76, 320, 421
Wollaston 81, 322
Wood, R. W..... 77
Woodruff, C. E..... 108
Woodruff, E. W..... 76
Worth, Claud.....65, 286, 290, 292, 312, 319
Wundt 151
Wyatt, L. K.....32, 114
Wyatt, Lloyd K. A case leading to the study of accommodation - convergence relationship 32

X

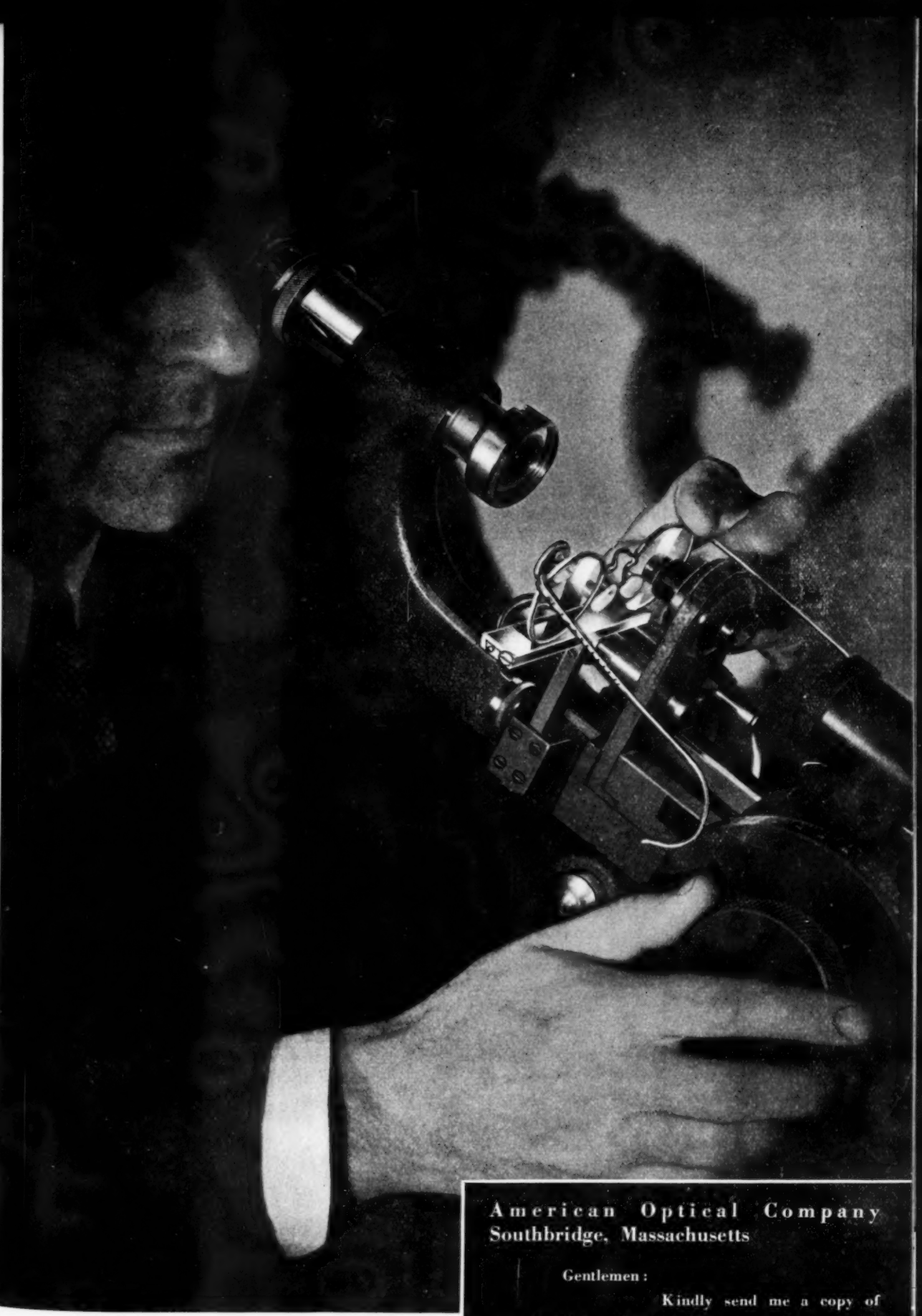
X-rays 81, 82, 83, 84, 85, 86, 90, 93, 94, 95, 124, 134, 174, 197

Y

Young, Thomas....150, 151, 322, 357, 358, 359

Z

Zinn, ring of.....49, 50, 51, 52, 53, 54
Zoethout 312



American Optical Company
Southbridge, Massachusetts

Gentlemen:

Kindly send me a copy of your booklet, "The AO Lensometer Junior".

COMPANY

Name _____

Street _____

City _____ *State* _____

A Christmas Gift to Your Colleague

Many of our readers who are interested in the success of this publication—The American Journal of Optometry, have asked us how they could help the editors "carry on" their task of publishing the "Journal". Our reply has always been, and is now, that we do not desire financial contributions, but you and all other readers may help in other ways.

You can do your share by securing one or more new subscriptions to the "Journal".

A gift that your friends and colleagues will appreciate most, is a yearly subscription or renewal of subscription to The American Journal of Optometry.

To assist you in doing this we have put these special rates in effect for the month of December.

SPECIAL CHRISTMAN GIFT RATES

One new subscription and your own renewal $6.00 ($3.00 each).
Two new subscriptions $6.00 ($3.00 each).
Two yearly renewals $7.00 ($3.50 each).
One renewal for two years $7.00.

The regular yearly subscription price is $4.00: orders for single subscriptions must be placed at this rate. Renewal of your own subscription may be entered at these rates

.....USE THIS COUPON—CLIP AND MAIL TODAY.....

AMERICAN JOURNAL OF OPTOMETRY
1502-4 Foshay Tower, Minneapolis, Minn.

Send the "JOURNAL" for One Year with my compliments:

to:Name _____

Address _____

Address _____

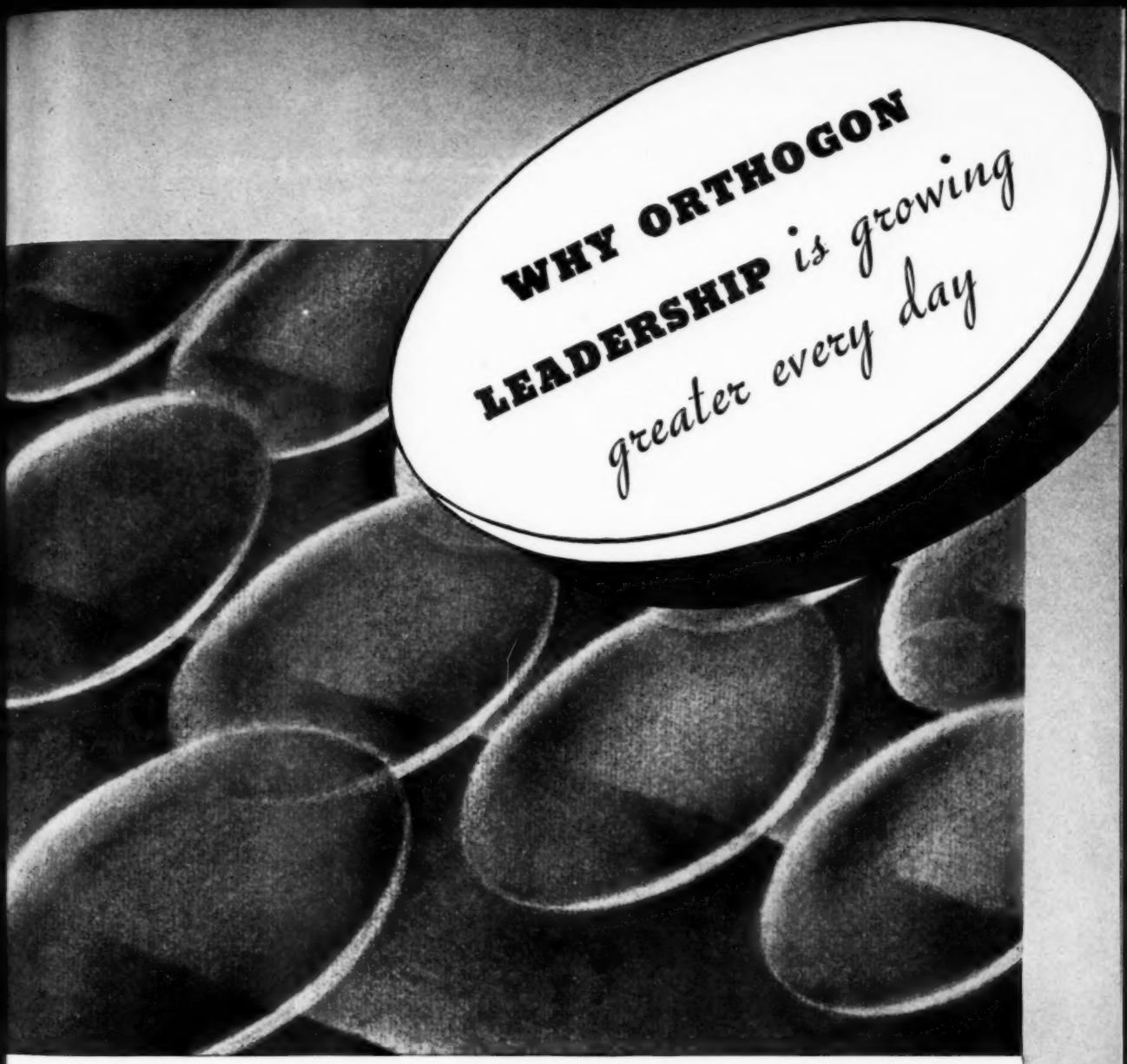
☐ My own renewal is to be included.
☐ My own renewal is not to be included.

Check—M. O.—Draft for the amount of $_____ is enclosed.

Signature _____

Address _____

IF ONE OF MY GIFTS DUPLICATES A SUBSCSIPSION, EXTEND THAT SUBSCRIPTION.



Significant are the figures which show the way Orthogon leadership is steadily increasing, day by day—year by year, but for all of this there is a reason. Orthogons are better lenses. They give an exact interpretation of the prescription—give refractionists the exact result ey try to achieve—give patients satisfaction. . . The superior Orthogon design suffi- ient in itself for better performance, is further enhanced by Bausch & Lomb glass nd Bausch & Lomb precision manufacture. Orthogon exclusiveness is maintained y the protective Orthogon sales policy. . . Prescribe them yourself and you'll readily nd their popularity well justified. *In Soft-Lite Too!*

Bausch & Lomb endorse the "Better Light—Better Sight" Campaign

BAUSCH & LOMB

Optical Company

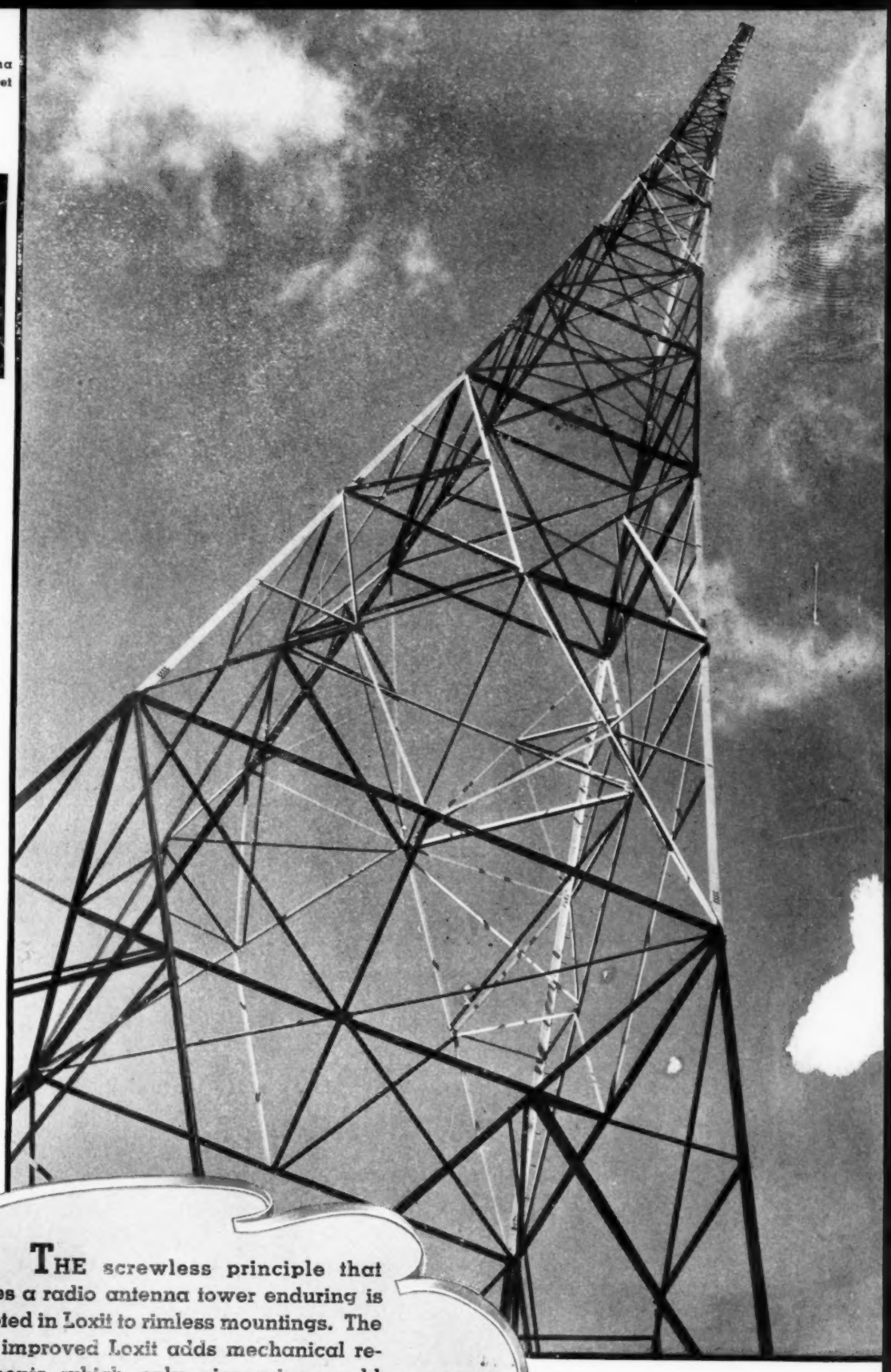
His long list of attributes would be a pride to anyone. Twenty-six years of practical experience in the optical field, and yet with more than an insight into scientific problems; years spent in the surface room and on the bench; an expert accountant and financial adviser; a college graduate with several degrees; an expert in ethical advertising with plenty of experience in planning programs that click; a dispenser; a mechanic; and a salesman par excellence with the ability of teaching others how to sell. . . . Who is this remarkable individual? Certainly it can't be any one man—and you're right, it isn't! But it does give you an idea of the experience placed at your disposal through a Riggs Representative, who with his organization behind him is able to work for and with you in building your practice along stable lines that lead to ultimate success and financial stability. . . . If you don't know him well now, it's to your advantage to get acquainted. See how he can serve you and how you can profit by the willing, dependable service he represents.

Riggs Optical Company

N B C. Radio Antenna
ower. Photo by Margaret
ourke-White.

The New Warrington
with Improved Loxit

*Bausch & Lomb en-
orse the "Better Light
Better Sight" Cam-
paign.*

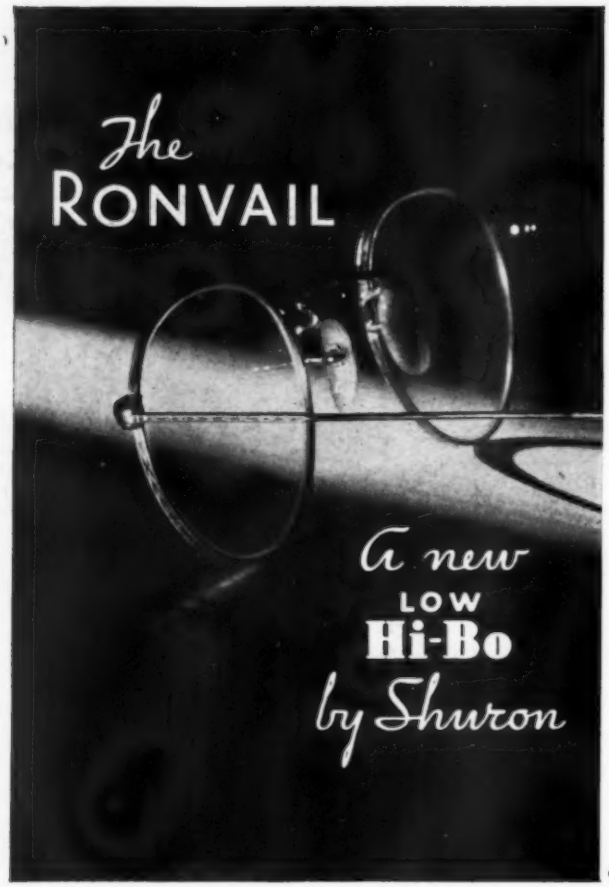


THE screwless principle that makes a radio antenna tower enduring is adapted in Loxit to rimless mountings. The new improved Loxit adds mechanical refinemenis which only pioneering could disclose. Loxit assures the very minimum of wobble and lens breakage, with demonstrable beauty. Bausch & Lomb Optical Co., Rochester, N. Y.

BAUSCH & LOMB
NEW IMPROVED

Loxit

the accepted method of mountin
rimless lenses without screws.



..Ronvail good looks and fitting quality.. the appealing modernity of a *modified* HiBo style *plus* Shuron quality. All of which makes the Ronvail Low HiBo a *sure* best-seller for 1935.

Shuron Optical Co., Inc.
Geneva, New York

WHICH BIFOCAL?
AND WHY?

A number of questions confront the refractionist each time he prescribes bifocal lenses. Which bifocal should be used? Why?—How high should the segments be? How much inset?—Should the lens be tilted? How much?—How far from the eyes should the lens be? The comfort and efficiency of the bifocals depend almost as much on the correct answering of these questions as on the correctness of the refraction.

WALCO BIFOCAL SERVICE

You may have these questions answered accurately and scientifically by using the Walco Bifocal Service. Here's how to do it. Send us a full and detailed prescription. We will analyze your prescription and return to you a complete report covering the above questions. The report will be unbiased. This service is free to refractionists, in the territories we serve, and details no obligation. Use it whenever there is the slightest doubt about bifocal lenses.

THE WALMAN OPTICAL COMPANY
229 MEDICAL ARTS BLDG.
MINNEAPOLIS, MINN.

FARGO GRAND FORKS ST. PAUL

#481